US010136754B2

(12) **United States Patent**
Smith et al.

(10) **Patent No.: US 10,136,754 B2**
(45) **Date of Patent: Nov. 27, 2018**

(54) **BEVERAGE MACHINE CARTRIDGE HOLDER**

(71) Applicant: **Keurig Green Mountain, Inc.**, Waterbury, VT (US)

(72) Inventors: **Geoffrey Y. Smith**, Melrose, MA (US); **Peter Thomas Launie, Jr.**, Worcester, MA (US); **Jonathan Alexander Brodie**, North Billerica, MA (US); **Stuart Jay Foster**, Somerville, MA (US); **Stoyan Plamenov Hristov**, Billerica, MA (US); **Jordan Dean Jack Greiner**, Winchester, MA (US); **Peter Nicholas Woskov**, Everett, MA (US); **Yoav Rabino**, Newton, MA (US); **James E. Shepard**, Marblehead, MA (US); **Ian Tinkler**, Wakefield, MA (US); **William T. Jacobs**, Lynnfield, MA (US); **Patrick J. Lazatin**, Woburn, MA (US); **William Philip McHugh**, Foxborough, MA (US); **Kevin Thomas Brandimarte**, Boston, MA (US); **Mario Liuzza**, Malden, MA (US); **Timothy Maclean**, Wakefield, MA (US)

(73) Assignee: **Keurig Green Mountain, Inc.**, Burlington, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 422 days.

(21) Appl. No.: **14/157,853**

(22) Filed: **Jan. 17, 2014**

(65) **Prior Publication Data**

US 2015/0201789 A1 Jul. 23, 2015

(51) **Int. Cl.**
A47J 31/40 (2006.01)
A47J 31/06 (2006.01)

(52) **U.S. Cl.**
CPC ***A47J 31/407*** (2013.01); ***A47J 31/0647*** (2013.01); ***A47J 31/0668*** (2013.01)

(58) **Field of Classification Search**
CPC A47J 31/0668; A47J 31/0647
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,550,652 A 11/1985 Da Silva
5,054,733 A * 10/1991 Shields B60N 3/101 248/154
(Continued)

FOREIGN PATENT DOCUMENTS

CN 1647730 A 8/2005
CN 1713843 A 12/2005
(Continued)

OTHER PUBLICATIONS

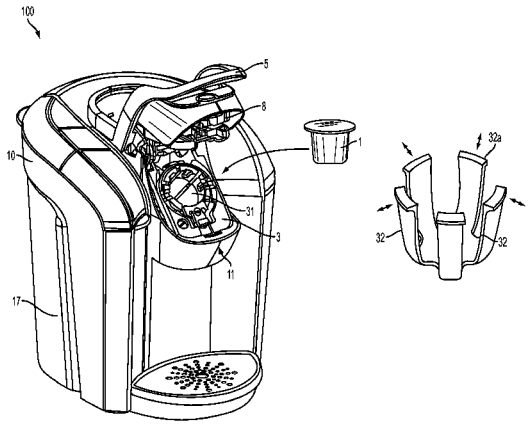
U.S. Appl. No. 15/056,316, filed Feb. 29, 2016, Tinkler.
(Continued)

Primary Examiner — Reginald L Alexander
Assistant Examiner — Lawrence Samuels
(74) *Attorney, Agent, or Firm* — Wolf, Greenfield & Sacks, P.C.

(57) **ABSTRACT**

A method and apparatus for opening and closing a cartridge holder of a beverage forming machine. The cartridge holder may have an opening arranged to receive and hold a cartridge with the cartridge holder. The opening may be adjustable in size and/or shape to allow the cartridge holder to receive and engage with cartridges of different size and/or shape. The cartridge holder may include one or more movable portions that are adjustable in position to effectively adjust a size and/or shape of the opening.

17 Claims, 14 Drawing Sheets



(58) **Field of Classification Search**
USPC 99/295, 300; 248/310, 311.2, 346.04
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,060,899	A *	10/1991	Lorence	B60N 3/102 224/401
5,242,702	A *	9/1993	Fond	A47J 31/0668 426/112
5,398,596	A *	3/1995	Fond	A47J 31/3695 99/295
5,402,707	A	4/1995	Fond et al.	
5,897,090	A *	4/1999	Smith	B01L 9/06 206/306
6,584,888	B2	7/2003	Cortese	
6,698,332	B2	3/2004	Kollep et al.	
6,705,580	B1 *	3/2004	Bain	B60N 3/106 248/311.2
6,955,116	B2	10/2005	Hale	
7,093,530	B2	8/2006	Meister et al.	
7,165,488	B2	1/2007	Bragg et al.	
7,216,582	B2	5/2007	Yoakim et al.	
7,255,039	B2	8/2007	Halliday	
7,318,372	B2	1/2008	Cooke	
7,325,479	B2	2/2008	Laigneau	
7,335,387	B2	2/2008	Hayes et al.	
7,513,192	B2	4/2009	Sullivan et al.	
7,540,232	B2	6/2009	Bates et al.	
7,569,243	B2	8/2009	Yoakim et al.	
8,087,528	B1 *	1/2012	Scarlett	A47G 23/0216 220/23.89
8,109,200	B2	2/2012	Hansen	
8,210,095	B2	7/2012	Brezovnik et al.	
8,361,527	B2 *	1/2013	Winkler	A47J 31/3695 426/77
8,857,317	B2 *	10/2014	Manser	A47J 31/407 99/289 R
8,967,038	B2 *	3/2015	Rivera	B65D 85/8043 99/295
9,295,357	B2 *	3/2016	Tinkler	B65D 85/8043
9,386,876	B2 *	7/2016	Denisart	A47J 31/0647
2003/0066431	A1 *	4/2003	Fanzutti	A47J 31/36 99/279
2004/0021048	A1 *	2/2004	Schaal	B60N 3/108 248/310
2004/0031394	A1 *	2/2004	Yoakim	A47J 31/0668 99/279
2004/0045257	A1	3/2004	Bakker et al.	
2004/0108428	A1 *	6/2004	Leopold	B60N 3/102 248/311.2
2005/0066819	A1 *	3/2005	Cooke	A47J 31/46 99/275
2006/0196364	A1 *	9/2006	Kirschner	A47J 31/3623 99/295
2008/0148957	A1	6/2008	Zanetti	
2010/0037779	A1	2/2010	Pecci et al.	
2010/0078531	A1 *	4/2010	Boinais	B60N 3/106 248/147
2010/0206177	A1	8/2010	Ricotti	
2011/0000377	A1	1/2011	Favre	
2011/0017071	A1	1/2011	Stefanoni	
2011/0100228	A1 *	5/2011	Rivera	A47J 31/446 99/281
2011/0111098	A1 *	5/2011	Ricotti	A47J 31/0642 426/89
2011/0274802	A1 *	11/2011	Rivera	A47J 31/0668 426/431
2012/0058226	A1 *	3/2012	Winkler	A47J 31/3695 426/79
2012/0171334	A1 *	7/2012	Yoakim	A47J 31/22 426/87
2012/0207895	A1 *	8/2012	Rivera	A47J 31/0689 426/433
2013/0114089	A1	5/2013	Jarisch et al.	
2013/0133522	A1 *	5/2013	Denisart	A47J 31/0647 99/295
2013/0139699	A1 *	6/2013	Rivera	B65D 85/8043 99/295
2014/0158852	A1 *	6/2014	Andersson	B60N 3/102 248/346.03
2015/0320254	A1 *	11/2015	Perentes	A47J 31/22 426/232
2015/0366397	A1 *	12/2015	Flick	A47J 31/0647 99/280
2017/0258265	A1 *	9/2017	Trombetta	A47J 31/44

FOREIGN PATENT DOCUMENTS

CN	2843251	Y	12/2006
CN	101001555	A	7/2007
CN	2446921	Y	9/2007
CN	102379630	A	3/2012
EP	1101430	A1	5/2001
EP	1107201	A2	6/2001
EP	1804629		3/2006
WO	WO 04004522	A1	1/2004
WO	WO 12156167	A1	11/2012
WO	WO 13079814	A1	6/2013
WO	WO 2013/192625	A1	12/2013

OTHER PUBLICATIONS

PCT/US2015/011542, dated Apr. 2, 2015, International Search Report and Written Opinion.
International Search Report and Written Opinion dated Apr. 2, 2015, from corresponding PCT Application No. PCT/US2015/011542.

* cited by examiner

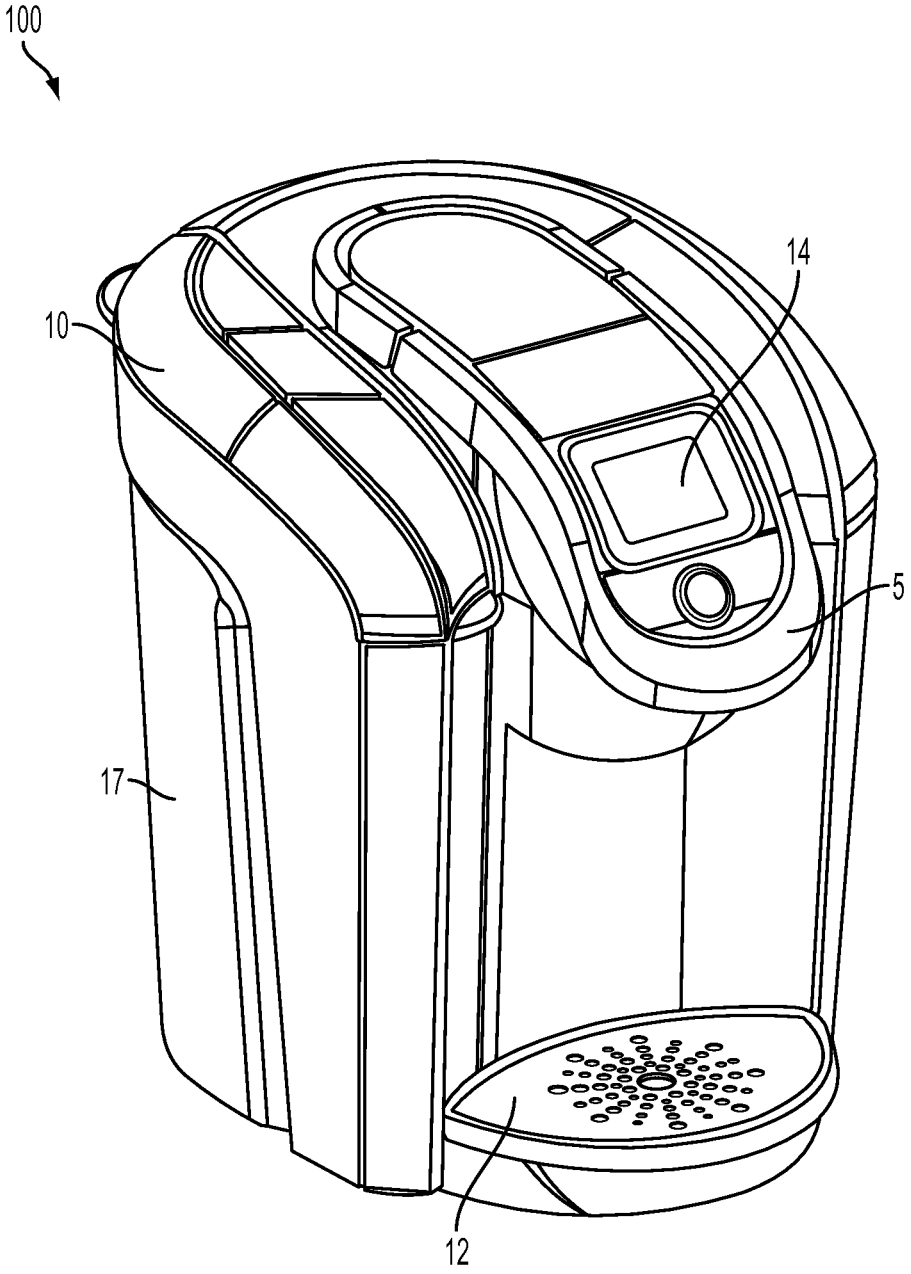


FIG. 1

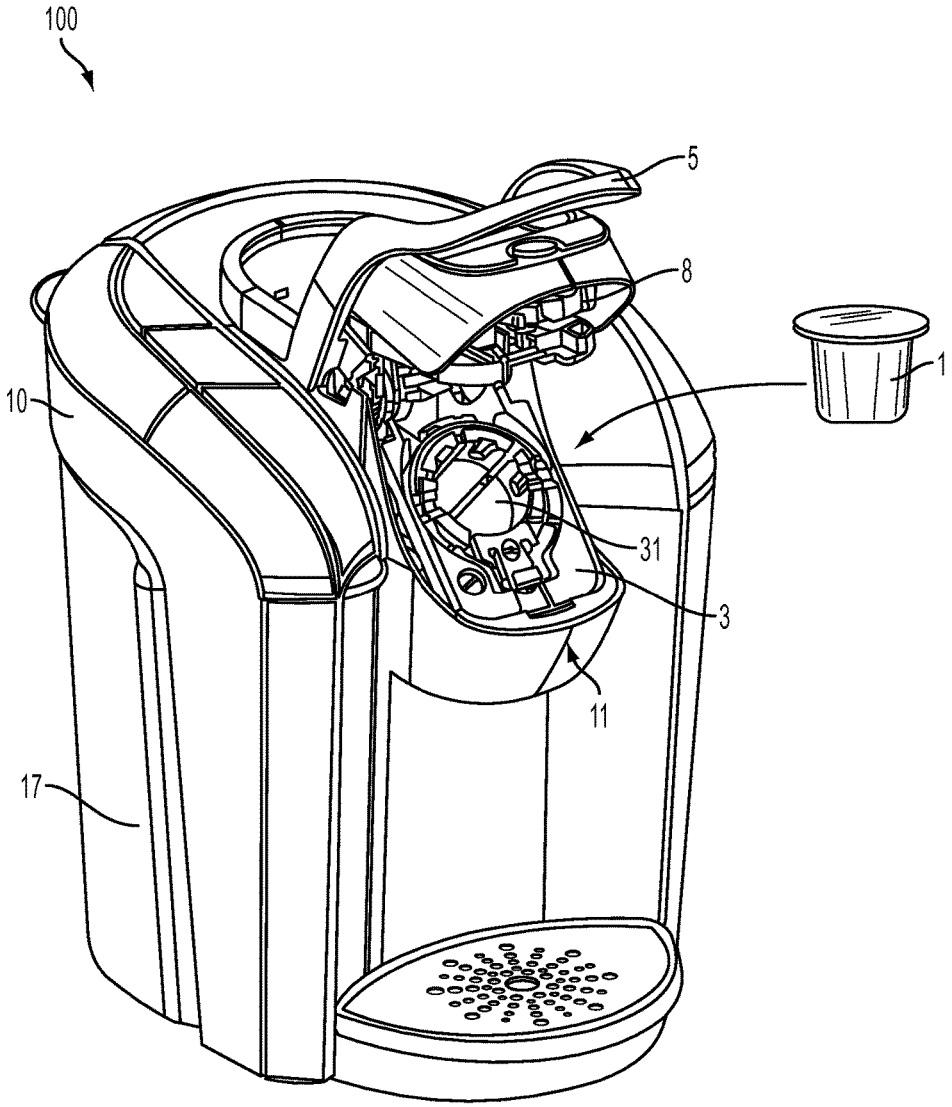


FIG. 2

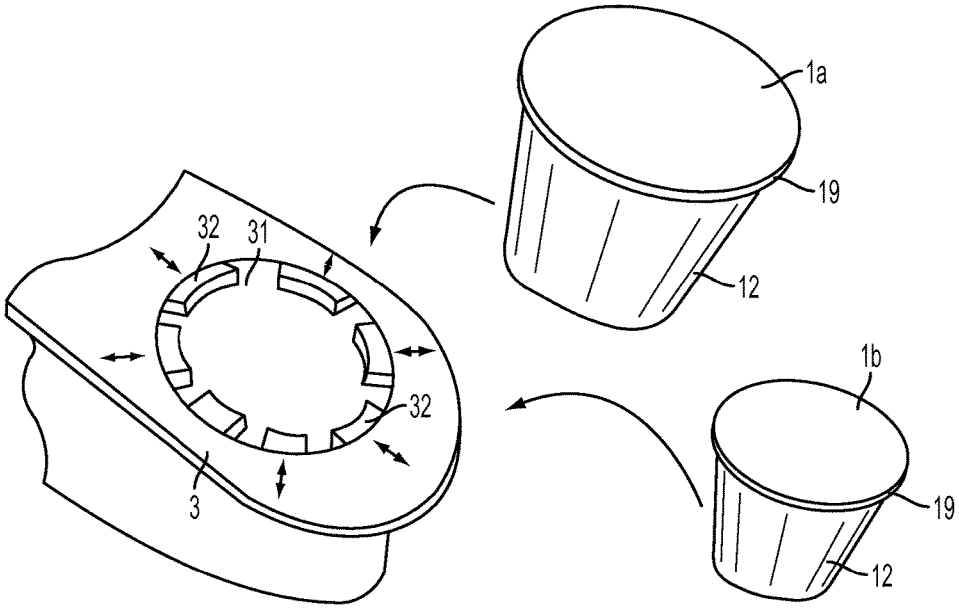


FIG. 3

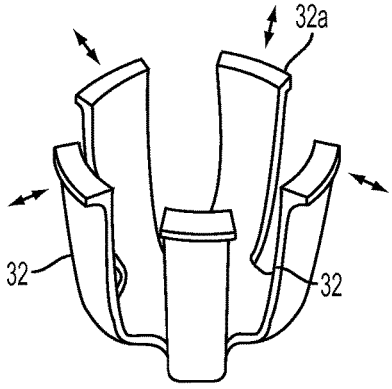


FIG. 4

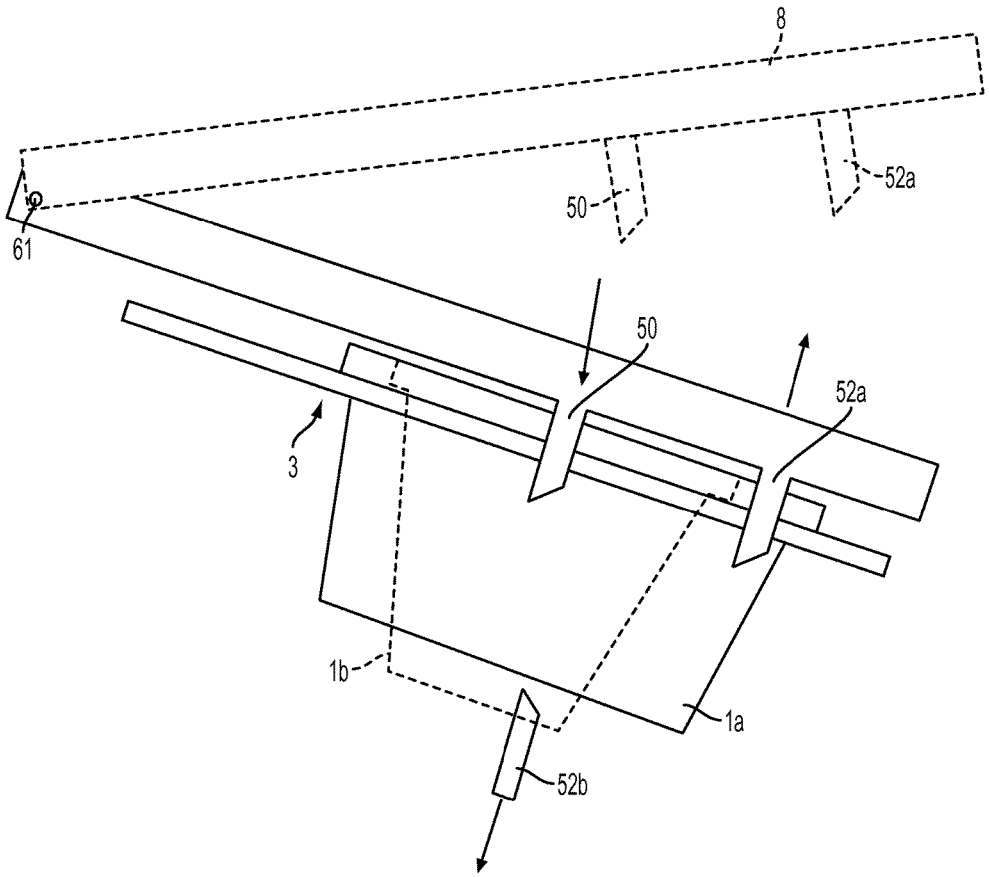


FIG. 5

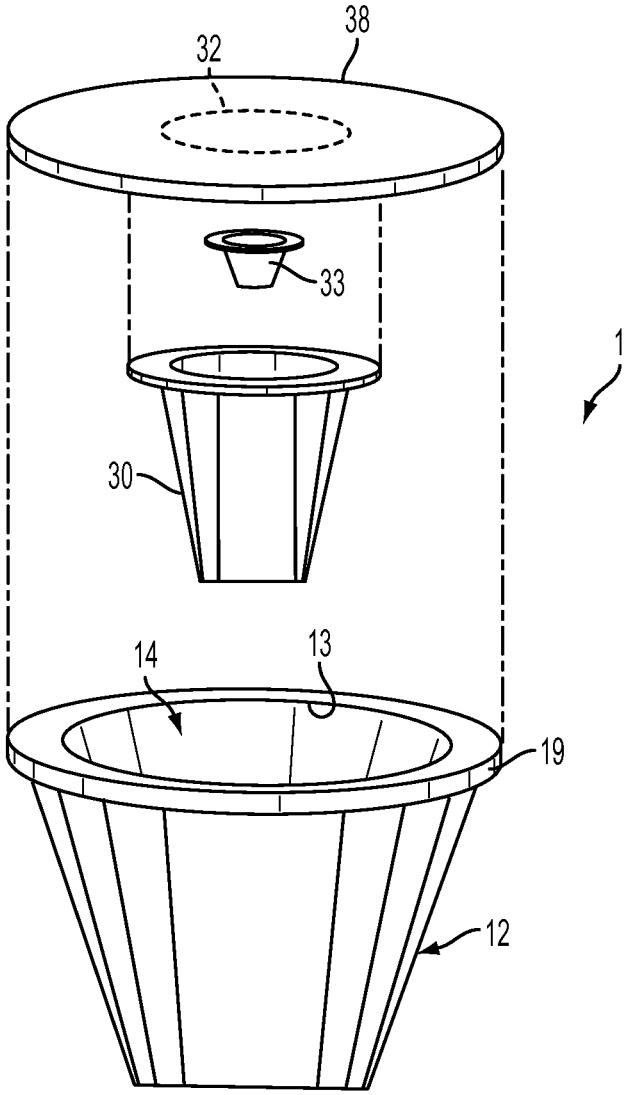


FIG. 6

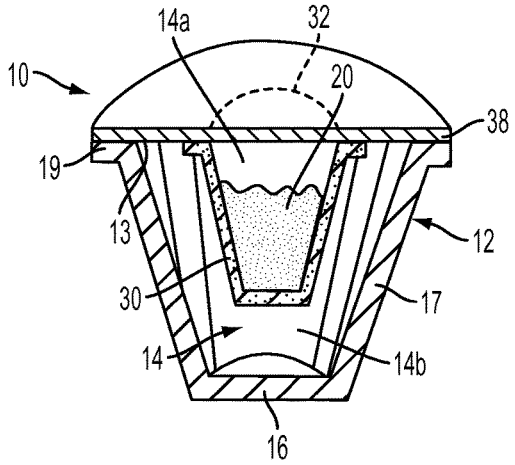


FIG. 7

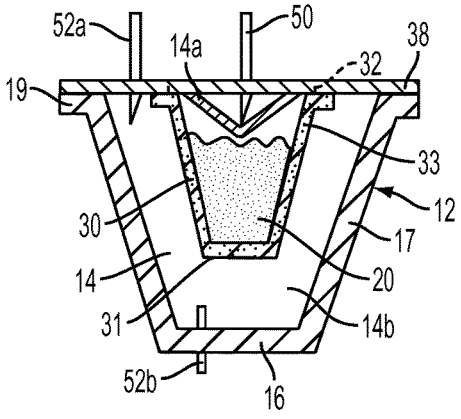


FIG. 8

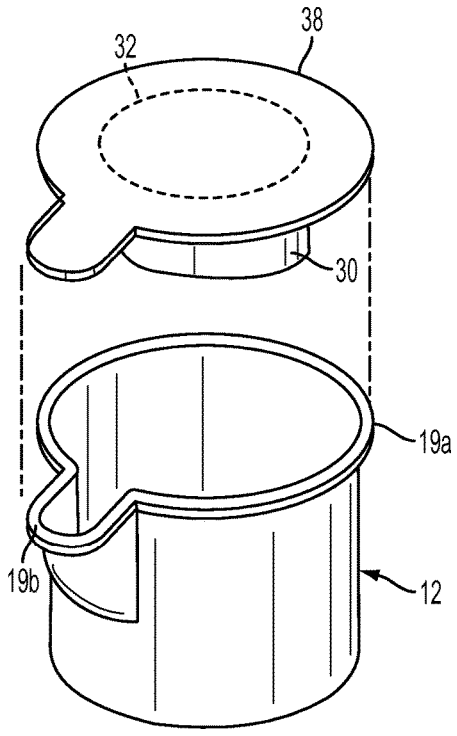


FIG. 9

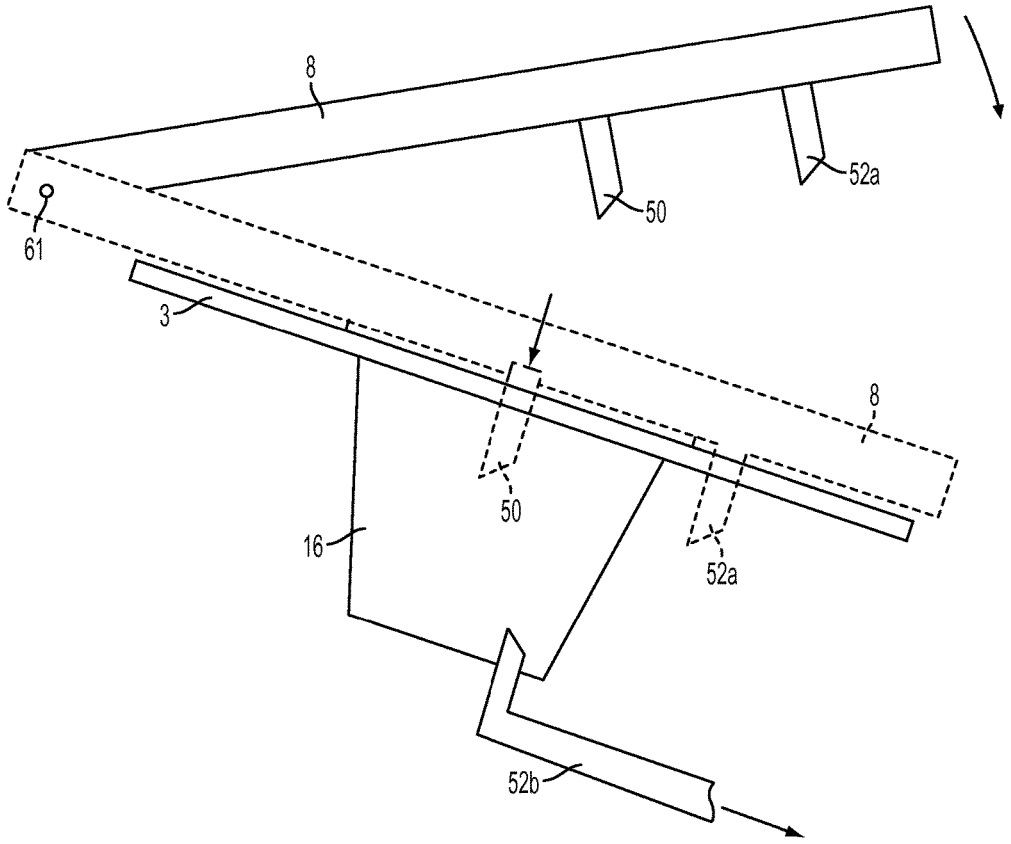


FIG. 10

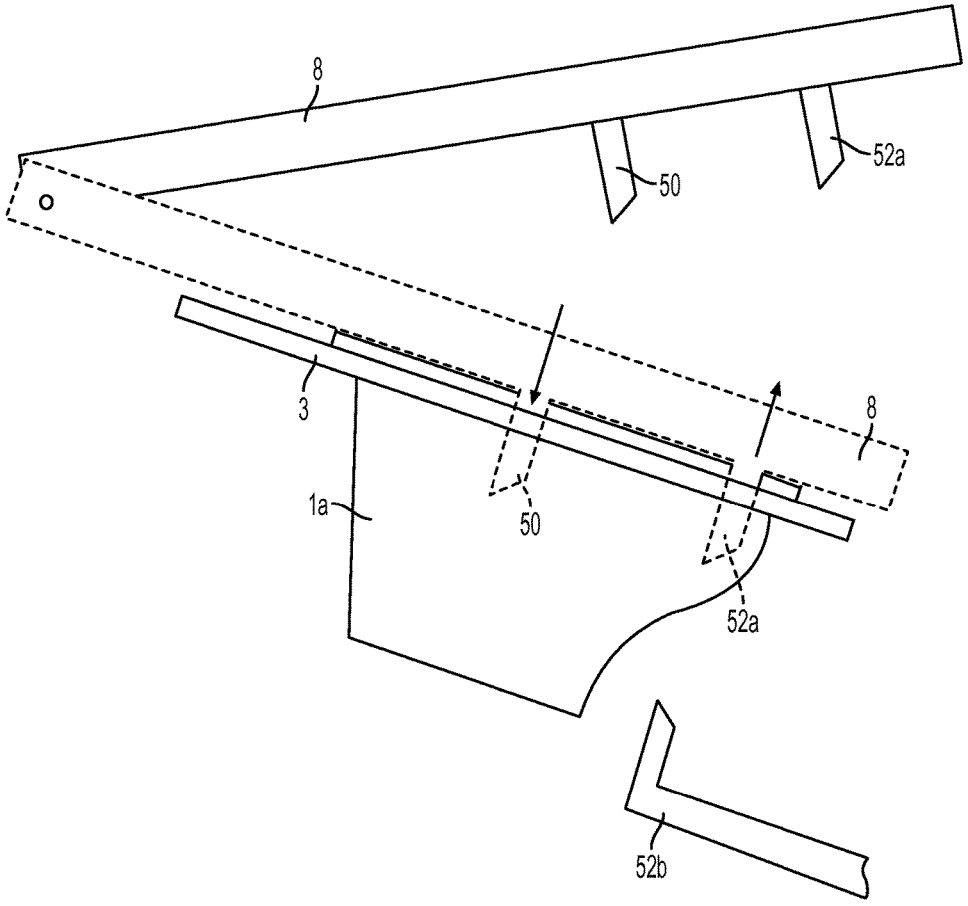


FIG. 11

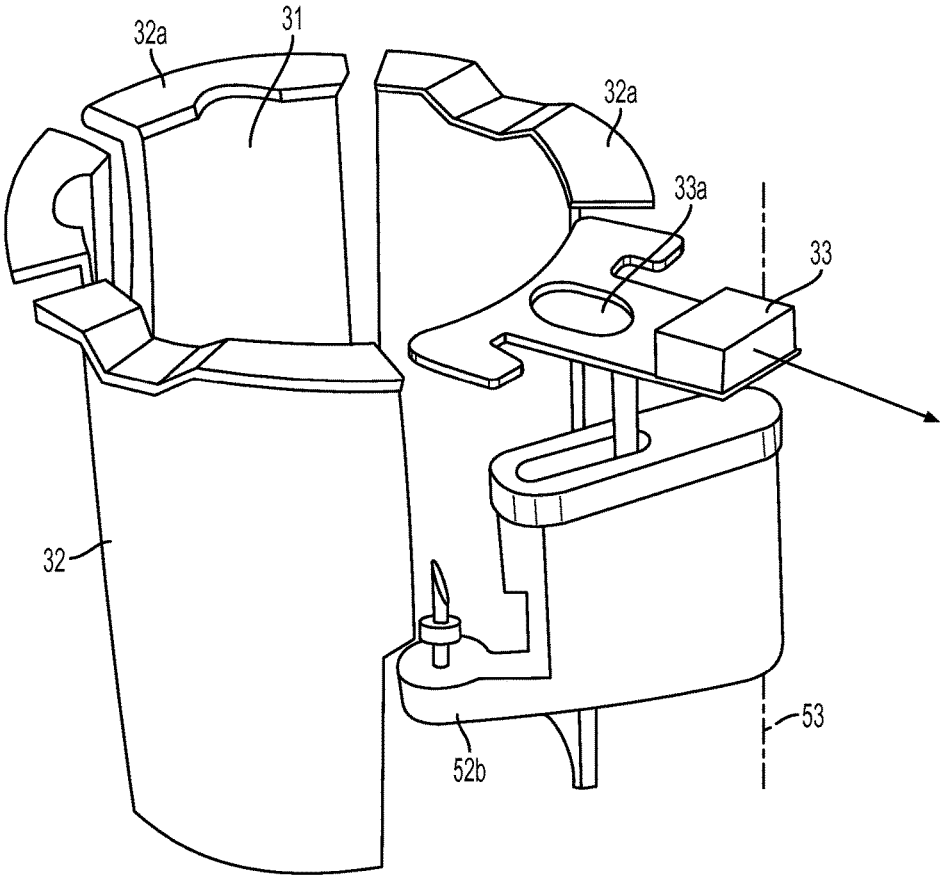


FIG. 12

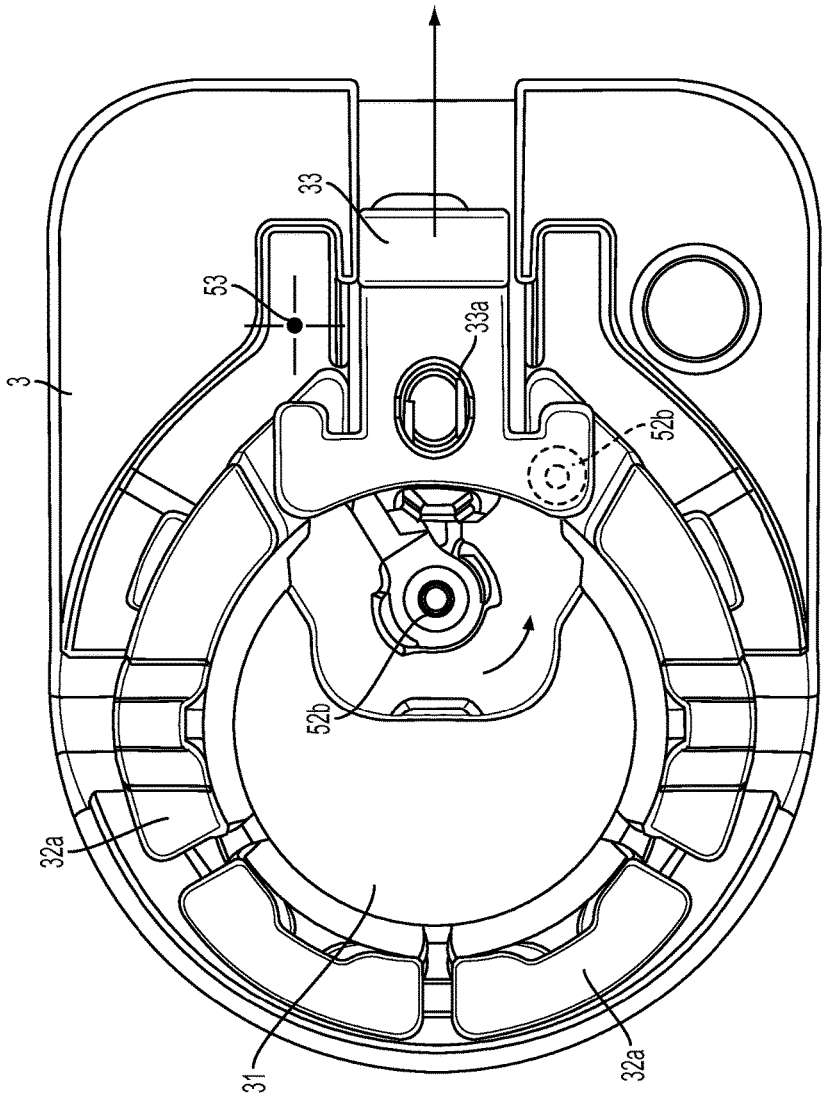


FIG. 13

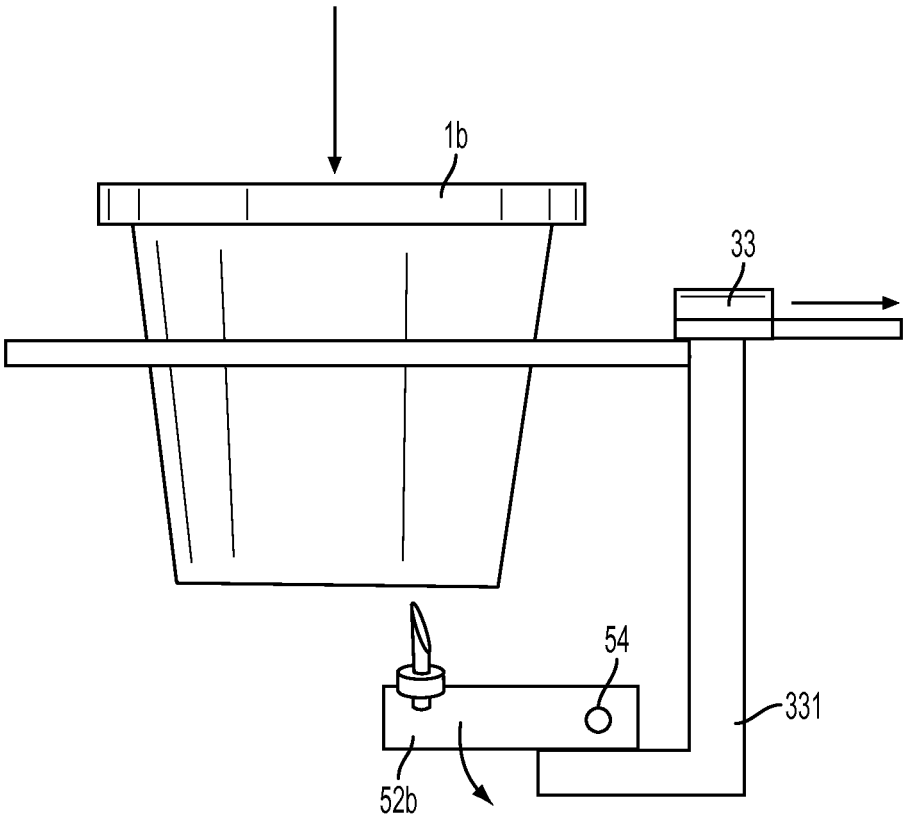


FIG. 14

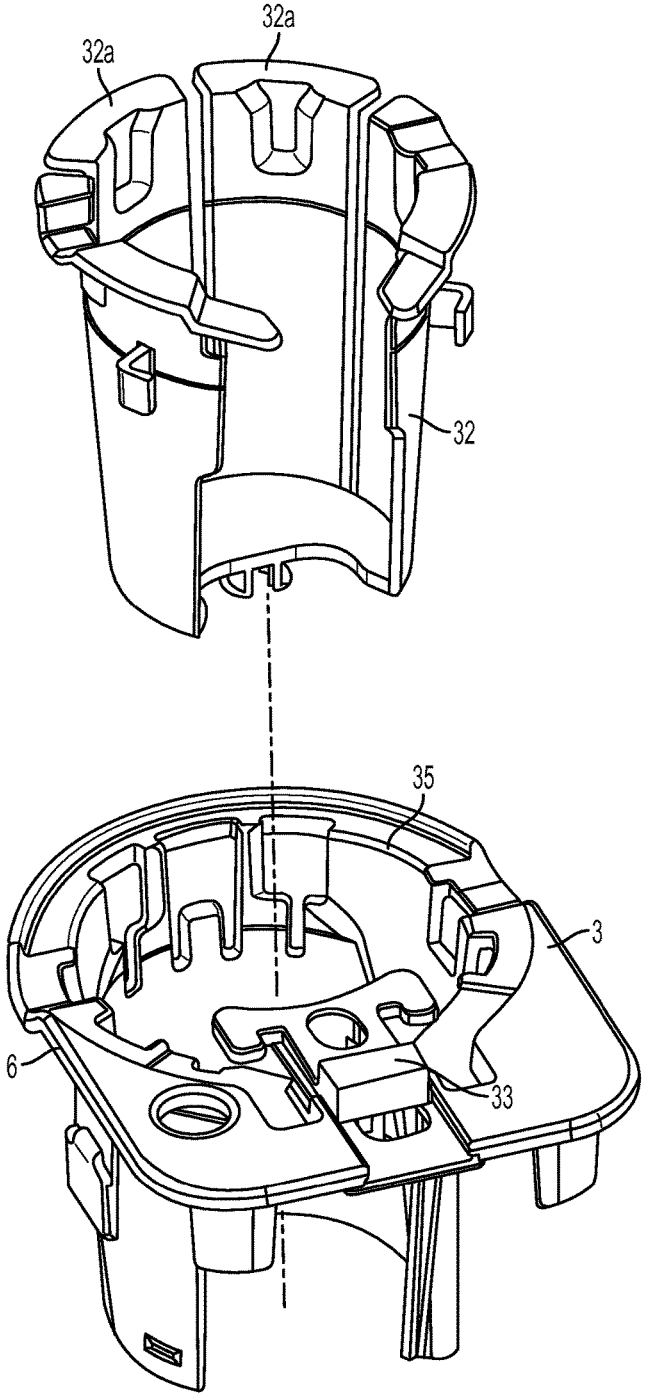


FIG. 15

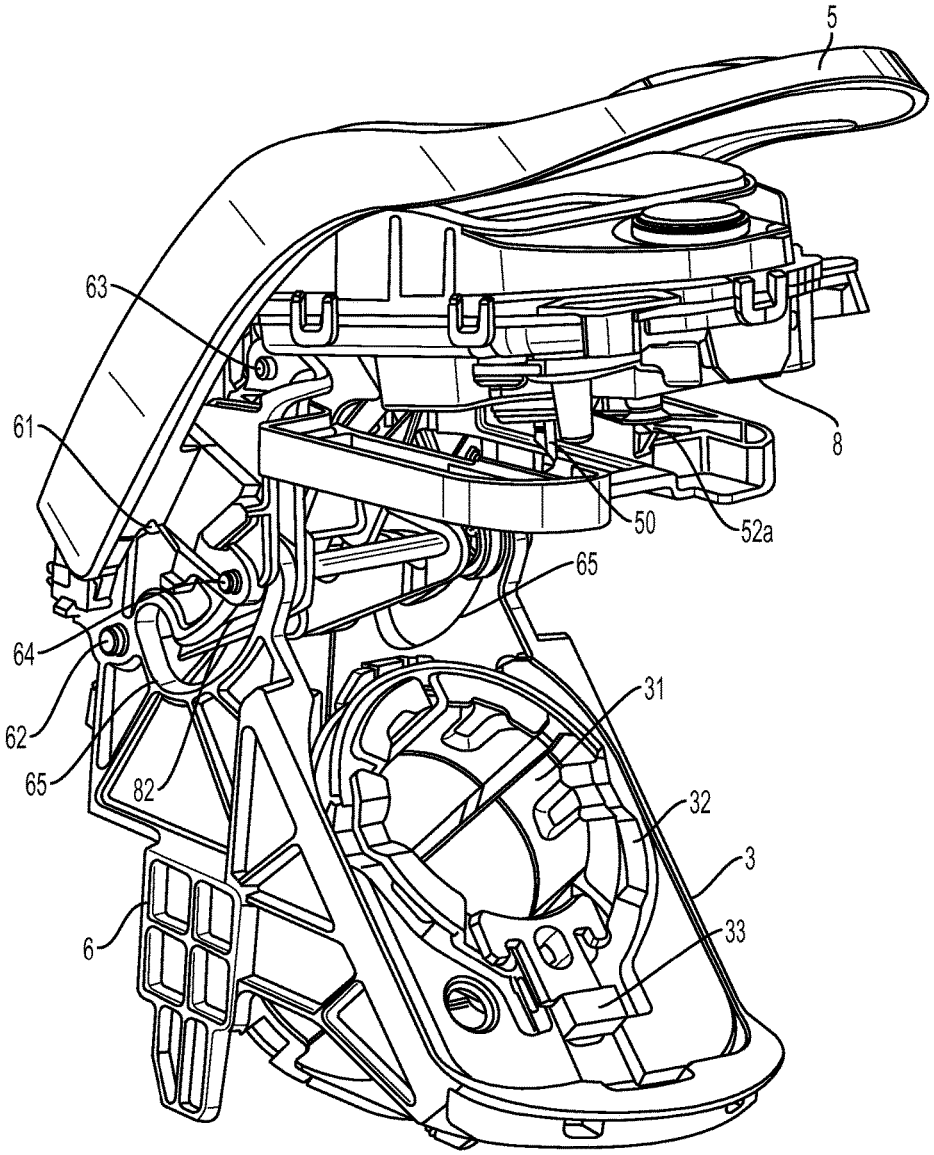


FIG. 16

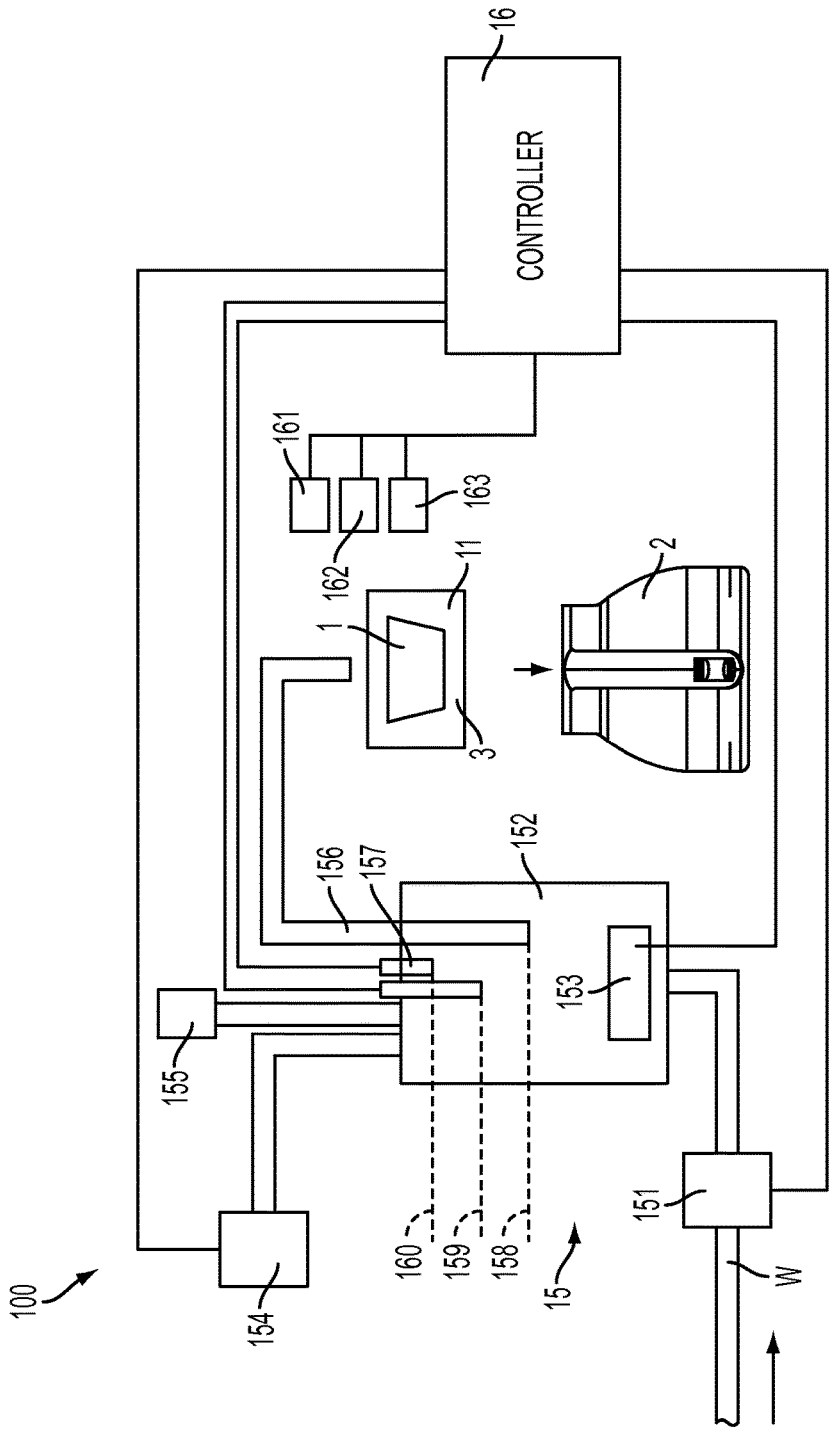

16
CONTROLLER
161
163
162
11
2
1
3
152
156
157
153
155
151
160
159
158
15
W
154
100

FIG. 17

BEVERAGE MACHINE CARTRIDGE HOLDER

BACKGROUND

1. Field of Invention

This invention relates to beverage forming systems, such as coffee brewers that use a liquid to form a coffee beverage.

2. Related Art

Beverage forming systems that use a liquid, such as water, to form a beverage are well known. For example, U.S. Pat. No. 8,361,527 discloses a beverage forming system that uses a beverage cartridge containing a beverage material to make a beverage by introducing liquid into the cartridge. Liquid provided to the cartridge may be heated in a tank prior to delivery to the cartridge.

SUMMARY OF INVENTION

Aspects of the invention relate to methods and apparatus for receiving cartridges of different size and/or shape in a cartridge holder of a beverage forming machine. For example, in some embodiments, the cartridge holder may be arranged to receive and support cartridges that have different sizes, e.g., circular rims of different diameters, and/or that have different shapes, e.g., one cartridge may have a circular rim while another cartridge may have a rim with an irregular shape, without the user having to manipulate an adapter or other component of the cartridge holder. In one embodiment, the cartridge holder may be arranged to expand and/or contract to adjust a size and/or shape of an opening in which cartridges are received. Thus, a user may simply place cartridges having different sizes or shapes in the cartridge holder without having to take any specific action to adjust a receiving opening of the holder or otherwise configure the machine.

In some embodiments, the cartridge holder may have an engagement portion that engages with, and optionally supports the weight of, cartridges placed in the holder. The engagement portion may include one or more radially movable portions which can move to adjust a size and/or shape of an opening in which the cartridges are received. In some embodiments, the engagement portion may include one or more compliant portions which can move resiliently such that the act of placing a cartridge in the holder causes movement of the compliant portions and adjustment of the size and/or shape of the receiving opening. Such an arrangement may make for an easy and convenient way for users to place differently sized/shaped cartridges in a cartridge holder.

In some embodiments, the cartridges may be differently sized and/or shaped in a region where the cartridge holder engages with, and supports the weight of, the cartridge. For example, an engagement portion of the cartridge holder may engage with cartridges at a rim of the cartridges (e.g., at a location just below and/or around a top edge where a sealing lid is attached to the cartridge). In some embodiments, the different cartridges may have rims of different diameters and/or shapes. For example, in one embodiment, a first cartridge may have a rim with an irregular shape (such as a rim with a circular section and a spout portion extending from one part of the circular section), and a second cartridge may have a circular rim. Despite these different shapes at the cartridge rim, the cartridge holder may accommodate both cartridge types while supporting the cartridges at a location at or near the rim.

In an aspect of the invention, a beverage forming machine may provide water or other fluid to different cartridges, and/or may receive beverage from different cartridges, using different inlet and/or outlet ports. For example, a first cartridge may receive water from an inlet port that pierces a top lid of the cartridge, and beverage may exit the cartridge to an outlet port that also pierces the top lid of the cartridge (though in a different location than the inlet port). However, a second cartridge held by the same cartridge holder may receive water from an inlet port that pierces the cartridge at a different location (such as the bottom of the cartridge as opposed to the top), and/or beverage may exit the second cartridge to an outlet port that pierces the cartridge at a different location (such as the bottom of the cartridge). For example, inflow of water into a first cartridge may be downwardly into the cartridge, while beverage outflow is upwardly from the cartridge. In contrast, inflow of water into a second cartridge may be downwardly into the cartridge, but beverage outflow may be downwardly from the second cartridge. Thus, inflow and/or outflow for different cartridges may occur in different relative places and/or directions.

In one embodiment, a first cartridge may be pierced in two locations at a top lid for inlet and outlet openings, respectively. Water or other fluid may be introduced into the cartridge in a downward direction through the inlet opening, and beverage may exit the cartridge in an upward direction through the outlet opening. In contrast, a second cartridge may be pierced in one location at the top lid for an inlet opening, and pierced at a location below the lid, e.g., at a bottom of the cartridge, for an outlet opening. Thus, water or other fluid may be introduced into the cartridge in a downward direction through the inlet opening, and beverage may exit the cartridge in a downward direction through the outlet opening. Such different flows may be accommodated by a single cartridge holder which can not only accommodate differently sized and/or shaped cartridges, but also different flow arrangements for fluid into and beverage out of the cartridges.

In one aspect of the invention, a beverage forming apparatus includes a frame arranged to support components of the beverage forming apparatus, and a cartridge holder including a cartridge engagement portion that defines an opening and that is arranged to engage with a cartridge placed in the opening. The engagement portion may include one or more radially movable sections that are movable to accommodate and engage with first and second cartridges that are differently sized and/or shaped relative to each other in a region where the engagement portion engages with the first and second cartridges. For example, the first and second cartridges may have differently sized rims, and the engagement portion may have one or more sections move to accommodate one or both of the cartridges. A cover may cooperate with the cartridge holder to at least partially enclose a cartridge held by the cartridge holder for formation of a beverage using the cartridge. For example, the cover may move to cover a part of a cartridge, or the cover may be fixed to the frame and the cartridge holder may move so that the cover is positioned over at least part of a cartridge. A liquid supply system at least partially supported by the frame may be arranged to provide a liquid for combination with a beverage medium in a cartridge held by the cartridge holder to form a beverage.

In one embodiment, the cartridge engagement portion may include a plurality of wall sections that are movable away from (and/or toward) each other to accommodate the first or second cartridge. The cartridge engagement portion

may include at least one trigger that is mounted for sliding movement away from the opening, e.g., the trigger may be movable to receive a spout of the first or second cartridge. In some embodiments, the cartridge engagement portion may engage with a rim of the first and second cartridge to support a weight of the cartridge, where the first cartridge has a rim with a first diameter, and the second cartridge has a rim with a second diameter that is smaller than the first diameter. The rim of the second cartridge may be circular, and the rim of the first cartridge may have a circular portion and a spout portion that extends outwardly from the circular portion.

In one embodiment, the cartridge engagement portion may include a plurality of wall portions that extend upwardly from a bottom of the engagement portion, where the wall portions are joined together, to a top of the engagement portion. The wall portions located at the top of the engagement portion may be radially movable relative to each other, e.g., so as to move to accommodate and engage with the first and second cartridge. The wall portions may be radially movable based on flexing movement of the wall portions relative to the bottom of the engagement portion or may be movable in other ways, such as by pivoting about a hinge.

In one embodiment, the cover includes a liquid inlet to introduce liquid from the liquid supply system to a cartridge held in the cartridge holder, and/or includes a first beverage outlet to receive beverage exiting a cartridge held in the cartridge holder. The apparatus may also include a second beverage outlet mounted to the cartridge holder and arranged to receive beverage exiting a cartridge held in the cartridge holder. The first and second beverage outlets may be selectively employed to receive beverage from a cartridge, e.g., depending on a type of cartridge. For example, the second beverage outlet may be selectively movable into and out of a cartridge receiving area of the cartridge holder based on whether the first or second cartridge is received in the cartridge holder. The liquid inlet and the first and second beverage outlets may each include a piercing element to pierce a cartridge, and the piercing elements of the liquid inlet and the first beverage outlet may face downwardly and the second beverage outlet may face upwardly.

In one embodiment, the engagement portion includes a plurality of radially movable sections and at least one of the radially movable sections has a smaller range of motion than at least one other radially movable section. This arrangement may help properly locate cartridges in the cartridge holder, e.g., so that an inlet and/or outlet may properly align with the cartridge. For example, since different cartridges may have different sizes, the engagement portions may be required to move different amounts to accommodate different cartridges. However, if the engagement portions do not move in an appropriate way, the cartridge may be misaligned with respect to an inlet and/or outlet. Thus, by having one or more engagement portions have a limited range of motion, the engagement portions may effectively function as stops for one or more cartridges, helping to ensure proper positioning of the cartridges. In one embodiment, the cartridge holder is arranged to receive a cartridge with a rim having a partially circular portion and a spout section extending outwardly from the partially circular portion. The at least one radially movable section with a smaller range of motion may be located on a side of the opening opposite where the spout section of the cartridge is received. This positioning of the movable section having a smaller range of motion can be helpful where the spout section contacts a trigger, which may resist radially outward movement to a greater extent than other engagement portions. By limiting movement of a movable portion opposite the trigger, the radially inward force of the trigger on the cartridge may be resisted, helping to properly position the cartridge.

In another aspect of the invention, a method for forming a beverage using a beverage forming apparatus includes providing a beverage forming apparatus having a cartridge holder with an engagement portion arranged to engage with a cartridge placed in an opening of the cartridge holder. A first or second cartridge may be provided into the opening of the cartridge holder, where the first and second cartridges are differently sized and/or shaped relative to each other in a region where the engagement portion engages with the first and second cartridges to support a weight of the cartridge. One or more sections of the engagement portion may be moved radially to accommodate and engage with a region of the first or second cartridge provided into the opening, and liquid may be combined with a beverage medium in the first or second cartridge held by the cartridge holder to form a beverage. In one embodiment, a plurality of wall sections may move away from each other to accommodate the first or second cartridge.

In one embodiment, a cover may cooperate with the cartridge holder to at least partially enclose a cartridge and liquid may be introduced from the liquid supply system to a cartridge held in the cartridge holder via a liquid inlet of the cover. Beverage may be received from the cartridge at a first beverage outlet, which may be attached to the cover. In some cases, beverage may be received at a first beverage outlet if a first cartridge is received in the cartridge holder, but beverage may be received at a second beverage outlet if a second cartridge is received in the cartridge holder. For example, the second beverage outlet may be selectively moved out of a cartridge receiving area of the cartridge holder if the first cartridge is received in the cartridge holder, and the first beverage outlet may interact with the first cartridge to receive beverage.

In another aspect of the invention, a beverage forming apparatus includes a frame arranged to support components of the beverage forming apparatus, and a cartridge holder having a cartridge engagement portion that defines an opening and that is arranged to engage with a cartridge placed in the opening and support a weight of the cartridge. The engagement portion may include one or more compliant sections that are movable to adjust a size and/or shape of the opening to accommodate and engage with first and second cartridges that are differently sized and/or shaped relative to each other in a region where the engagement portion engages with the first and second cartridges. A cover may be arranged to cooperate with the cartridge holder to at least partially enclose a cartridge held by the cartridge holder for formation of a beverage using the cartridge, and a liquid supply system may be arranged to provide a liquid for combination with a beverage medium in a cartridge held by the cartridge holder to form a beverage. In one embodiment, the one or more compliant sections each include a resilient element that deforms in response to insertion of the first or second cartridge into the opening of the cartridge holder. For example, the one or more compliant sections may include a plurality of wall sections that are movable away from each other to accommodate the first or second cartridge. The one or more compliant sections may include at least one trigger that is mounted for sliding movement away from the opening, e.g., the trigger may be movable to receive a spout of the first or second cartridge. Other features described above may be incorporated as well, such as having the one or more

compliant sections include wall elements that are joined together and are capable of flexing to receive one or more cartridges.

In another aspect of the invention, a method for forming a beverage using a beverage forming apparatus includes providing a beverage forming apparatus having a cartridge holder with an engagement portion arranged to engage with a cartridge placed in an opening of the cartridge holder and support a weight of the cartridge. The engagement portion may include one or more resilient elements that are movable to adjust a size and/or shape of the opening. A first or second cartridge may be placed into the opening of the cartridge holder, where the first and second cartridges are differently sized and/or shaped relative to each other in a region where the engagement portion engages with the first and second cartridges to support a weight of the cartridge. One or more resilient elements of the engagement portion may be moved to adjust a size and/or shape of the opening and to accommodate and engage with a region of the first or second cartridge provided into the opening, and liquid may be combined with a beverage medium in the first or second cartridge held by the cartridge holder to form a beverage.

These and other aspects of the invention will be apparent from the following description and claims.

BRIEF DESCRIPTION OF DRAWINGS

Aspects of the invention are described below with reference to the following drawings in which like numerals reference like elements, and wherein:

FIG. **1** is a front perspective view of a beverage forming apparatus in an illustrative embodiment;

FIG. **2** is a front perspective view of the FIG. **1** embodiment with the cartridge holder exposed to receive a cartridge;

FIG. **3** is a perspective side view of a cartridge holder arranged to receive cartridges having different sizes;

FIG. **4** is a perspective side view of an engagement portion for the cartridge holder mechanism in the FIG. **3** embodiment;

FIG. **5** is a schematic side view of a cartridge holder and cover in an illustrative embodiment;

FIG. **6** is an exploded view of a beverage cartridge in an illustrative embodiment;

FIG. **7** is an assembled, cross-sectional view of the cartridge of FIG. **6**;

FIG. **8** is a cross-sectional view of the FIG. **6** cartridge and optional inlet and outlet locations for the cartridge;

FIG. **9** is perspective view of another beverage cartridge arrangement that may be received by a cartridge holder also arranged to receive the cartridge of FIGS. **6-8**;

FIG. **10** is schematic side view of a cartridge holder and cover in an illustrative embodiment in which different outlet ports are used for different cartridges;

FIG. **11** is a schematic side view of the cartridge holder of FIG. **10** illustrating how a different outlet port is used with a different cartridge than that shown in FIG. **10**;

FIG. **12** is a side view of a cartridge holder having an outlet port that is pivotal about a vertical axis;

FIG. **13** is a top view of the FIG. **12** cartridge holder;

FIG. **14** is a side view of a cartridge holder having an outlet port that is pivotal about a horizontal axis;

FIG. **15** is a partially exploded view of a cartridge holder employing the engagement portion of FIG. **4**;

FIG. **16** is a perspective view of a cartridge holder, associated cover and components for moving the cover in an illustrative embodiment; and

FIG. **17** is a schematic diagram of components of a beverage forming apparatus in an illustrative embodiment.

DETAILED DESCRIPTION

It should be understood that aspects of the invention are described herein with reference to certain illustrative embodiments and the figures. The illustrative embodiments described herein are not necessarily intended to show all aspects of the invention, but rather are used to describe a few illustrative embodiments. Thus, aspects of the invention are not intended to be construed narrowly in view of the illustrative embodiments. In addition, it should be understood that aspects of the invention may be used alone or in any suitable combination with other aspects of the invention.

FIGS. **1** and **2** show a perspective view of a beverage forming apparatus **100** in an illustrative embodiment that incorporates aspects of the invention. Although the beverage forming apparatus **100** may be used to form any suitable beverage, such as tea, coffee, other infusion-type beverages, beverages formed from a liquid or powdered concentrate, soups, juices or other beverages made from dried materials, or other, in this illustrative embodiment, the apparatus **100** is arranged to form coffee or tea beverages. As is known in the art, a beverage cartridge **1** may be provided to the apparatus **100** and used to form a beverage that is deposited into a container **2**. The cartridge **1** may be manually or automatically placed in a cartridge holder **3** of a beverage forming station **11** of the beverage forming machine **10**. For example, the cartridge holder **3** may be exposed to receive the cartridge **1** when the user operates a handle **5** or other actuator. In this embodiment, movement of the handle **5** or other actuator may cause a cover **8** to move relative to the cartridge holder **3** (or the cover **8** and holder **3** to otherwise move relative to each other, e.g., by having the holder **3** move) to expose the holder **3** for reception of a cartridge **1**. With the cartridge **1** placed in the cartridge holder **3**, the actuator **5** may be operated to at least partially enclose the cartridge **1**, e.g., so that the cover **8** moves to cooperate with the holder **3** to at least partially enclose the cartridge **1** so water or other precursor liquid can be introduced into the cartridge **1** to form a beverage. For example, with the cartridge **1** held in the beverage forming station **11** by the cartridge holder **3**, the cartridge **1** may be pierced to form inlet and outlet openings through which water or other precursor liquid enters the cartridge **1** and beverage that exits the cartridge **1**, respectively. U.S. Pat. No. 8,361,527 describes a cartridge and a system for introducing liquid into the cartridge that may be used in embodiments of this invention, and is hereby incorporated by reference in its entirety. Of course, aspects of the invention may be employed with any suitably arranged apparatus **100**, including drip-type coffee brewers, carbonated beverage machines, and others arranged to form a beverage regardless of how the beverage is formed. For example, a cartridge **1** may include any suitable materials to form a beverage, such as a carbon dioxide source used to carbonate water, a beverage mix, etc.

In this embodiment, the beverage forming machine **10** includes a housing **17** that houses and/or supports components of the machine **10**, such as a user interface **14** used to control system operation, and defines a container receiving area **12** at which the container **2** is positionable to receive beverage dispensed by the machine **10** via a beverage outlet. Thus, at the container receiving area **12**, the container **2** is associated with the machine **10** to receive a dispensed beverage and may be supported by the housing **17**. The

container **2** may be received at the container receiving area **12** so that the container **2** is at least partially surrounded by the housing **17**, or the container **2** may be more exposed when at the container receiving area **12**, as shown in FIG. **2**.

In accordance with an aspect of the invention, a cartridge holder having an opening arranged to receive and support a cartridge may be arranged to receive cartridges of different sizes and/or shapes. In particular, the cartridges may have different sizes and/or shapes in a region where the cartridge holder engages with the cartridge to support the weight of the cartridge. For example, the cartridge holder may engage cartridges at a rim (e.g., at or below a flange to which a lid of the cartridge is attached), and different cartridges may have different rim sizes and/or shapes. In some embodiments, the cartridge holder may include an engagement portion that engages with the cartridges to support the cartridges in the holder. The engagement portion may include one or more movable portions that may move relative to each other to adjust a size and/or shape of an opening of the cartridge holder at which the cartridges are received. For example, the movable portions may be radially movable relative to each other so as to enlarge and/or reduce the size of the opening, or to adjust a shape of the opening. Thus, in some embodiments, radial movement of the movable portions may move one or more of the movable portions in a plane that is parallel to a plane of the opening. Radial movement need not necessarily involve linear movement of a portion along a radius or diameter of a circularly shaped opening. Instead, the opening may have any suitable shape, such as a square or other polygon, and the movable portions may move in any suitable way to change the size and/or shape of the opening, such as along a linear path, a curved path, a rotational path, etc. For example, a cylindrical element may rotate about a longitudinal axis that is offset from the longitudinal center of the cylinder so as to effectively move the contact area of the cylinder radially relative to the opening. Such movement and others are termed radial movement herein. The moveable portions of the engagement portion may be compliant, e.g., include resilient sections that flex or otherwise resiliently deform to adjust the size of the opening so as to accommodate cartridges of different size/shape at the region where the engagement portion engages with the cartridges. The parts of the engagement portion at the opening may engage with a cartridge to support the weight of the cartridge or otherwise exert a force on the cartridge, e.g., to clamp the cartridge in place.

FIG. **3** shows a partial, close up view of a cartridge holder **3** that may be employed in the FIGS. **1** and **2** embodiment. In this embodiment, an opening **31** of the cartridge holder **3** is oriented in an upwardly inclined position with the opening **31** facing toward a front of the machine **10**. In this upwardly inclined position, an axis that is perpendicular to the plane of the opening **31** may be arranged at an angle above the horizontal of about 25 to 85 degrees, e.g., about 45 degrees. Such an orientation may make placement of a cartridge in the holder easy and convenient for a user, e.g., the holder **3** may securely hold the cartridge **1** with the cover **8** in the open position. Thereafter, the handle **5** may be returned to the position of FIG. **1**, and in response the cover **8** may move to a closed position, e.g., such that the cover **8** is positioned over the opening **31**. Closing of the cover **8** may also cause one or more piercing elements to pierce the cartridge, e.g., to introduce liquid into the cartridge or allow beverage to exit. Note, however, that the cartridge holder **3** need not be positioned in an upwardly inclined orientation, and instead may be arranged in a horizontal, vertical, inverted or other orientation. Also, the cartridge holder **3** may move relative to the cover **8** and/or housing **17**, e.g., in a horizontal, translational movement, in a pivoting motion, etc. to open and close the beverage forming station **11**.

In accordance with an aspect of the invention, the cartridge holder **3** may include one or more moveable portions **32** that are movable to adjust a size of the opening **31** at which the cartridges are received and engaged by the cartridge holder **3**. For example, in this embodiment, the cartridge holder **3** is arranged to receive both a first cartridge **1***a* and a second cartridge **1***b* that are different from each other, e.g., the first cartridge **1***a* has a circular rim **19** with a diameter that is larger than the diameter of the circular rim **19** of the second cartridge **1***b*. The sizes of the rim diameters and the difference between the two may be any suitable value, e.g., one rim **19** may have diameter of about 50 mm and the other rim **19** diameter may be about 63 mm. The rim **19** diameter is relevant in this embodiment because the cartridge holder **3** engages with the cartridges **1** in a region at or near (e.g., just below) the rim **19**. For example, the cartridge may be received into the opening **31** such that an underside of the rim **19** rests on the movable portions **32**. In cases where the cartridges **1** are engaged by the holder **3** in other regions, such as at a mid-section of the cartridges **1**, at a bottom of the cartridges, etc., the cartridges **1** may be different in size and/or shape in these regions.

In this embodiment, the movable portions **32** are movable in a radial direction as shown by the arrows so that the size of the opening **31** can be adjusted to receive the differently sized cartridges **1***a*, **1***b*. The movable portions **32** may move in any suitable way, such as being spring biased to move radially inwardly so that when the first and/or second cartridge **1***a*, **1***b* is placed in the holder **3**, the movable portions **32** are pushed outwardly by the cartridge **1***a*, **1***b* sidewall **12** until the rim **19** contacts the movable portions **32** or other stop. In the embodiment shown in FIG. **3**, each of the movable portions **32** may be slidable in a corresponding slot of the cartridge holder **3**, and a coil spring (not shown) may bias each of the movable portions **32** to move radially inwardly in the corresponding slot. A stop or other feature may limit each movable portion's **32** radial movement, e.g., the movable portions **32** may be normally biased to a position in which the movable portions **32** define a size and/or shape of the opening **31** that corresponds to the smaller second cartridge **1***b*. Thus, when the second cartridge **1***b* is placed in the holder **3**, the movable portions **32** need not move to allow the holder to receive the second cartridge **1***b*. However, the movable portions **32** may move radially to accept the larger first cartridge **1***a*.

In other embodiments, the movable portions **32** may move in other ways, such as by a cam mechanism, screw drive, linkage, or other. For example, the movable portions may each have a cam follower pin that engages with a corresponding cam slot of a cam ring that extends around the opening **31**. When the cam ring is rotated, the cam slots may move the follower pins radially in/out, and thereby moving the movable portions in/out. Other arrangements are possible, such as a diaphragm or iris mechanism used to open/close a photographic camera diaphragm so as to control an amount of light entering the camera lens or a collet chuck arrangement used to hold drill bits in a hand-held drill. In such cases, the cartridge holder **3** may include a user-operable element, such as a knob or ring, that is movable to adjust a size and/or shape of the opening **31**.

In another embodiment, an engagement portion of the cartridge holder may include one or more "finger" or wall portions that are arranged to move to accommodate differently sized/shaped cartridges. For example, FIG. **4** shows

one embodiment of an engagement portion that includes five "fingers" or wall portions **32**. The wall portions **32** are arranged together to form a sort of basket in which the cartridges **1** are placed. Thus, the structure shown in FIG. **4** may be positioned in the cartridge holder **3** such that top parts **32***a* of the wall portions **32** define the opening **31** of the holder **3**, e.g., the top parts **32***a* may contact an underside of the rim **19** of the cartridges **1**. The wall portions **32** may be joined together at a bottom of the engagement portion and include at least one resilient portion that allows the wall portions **32** to flex outwardly and/or inwardly so as to adjust a size and/or shape of the opening **31**. For example, with the wall portions **32** at rest in an undeformed state, the smaller second cartridge **1***b* may be received into the opening **31** defined by the wall portions **32** with little or no movement of the wall portions **32**. However, when the larger first cartridge **1***a* is placed in the opening **31**, the sidewall **12** of the cartridge **1***a* may force the wall portions **32** to flex outwardly until the underside of the rim **19** contacts the top parts **32***a* of the wall portions **32**.

FIGS. **3** and **4** also illustrate another aspect of the invention, i.e., that the cartridge holder may include one or more compliant portions that are resiliently deformable or otherwise movable to accommodate differently sized and/or shaped cartridges (at least in the region where the cartridges are engaged by the cartridge holder). That is, the engagement portion of FIG. **4** is compliant in that the wall portions **32** can resiliently change shape to accommodate differently sized and shaped cartridges (the same is true of the spring-loaded movable portions **32** in FIG. **3**). This can allow for simplified cartridge insertion into a holder **3**, e.g., because neither the machine nor user need take any specific action to adjust the size and/or shape of the opening **31**. Instead, the interaction of the cartridge **1** with the cartridge holder **3** may itself adjust the size and/or shape of the opening **31** due to the compliant nature of the engagement portion. Of course, other arrangements for compliant movable portions **32** are possible, such as forming the movable portions in FIG. **3** of a foam or silicone material that deforms to adjust a size and/or shape of the opening **31**.

In accordance with another aspect of the invention, different inlet and/or outlet ports at the cartridge holder may be used with different cartridges to form a beverage. For example, in one embodiment, a first outlet port may be used to receive beverage from a first cartridge, and a second outlet port may be used to receive beverage from a second cartridge. Such an arrangement may be useful, for example, when a first cartridge type is configured to be pierced at a top for a beverage outlet, and a second cartridge type is configured to be pierced at a bottom for a beverage outlet. FIG. **5** shows a schematic side view of an inlet and outlet port configuration that may be employed in an embodiment like that shown in FIG. **3** where a cartridge holder is arranged to receive cartridges of different sizes and/or shapes. As can be seen in FIG. **5**, the cover **8** of the beverage machine **10** may include an inlet port **50** and an outlet port **52***a*, and may be pivotal about a cover pivot **81** between an open position (shown in dashed line) and a closed position (shown in solid line). In this embodiment, the inlet and outlet ports **50**, **52***a* include piercing elements to pierce the cartridge **1** and form an opening, but piercing elements for either or both ports is not required. Instead, the cartridge **1** may have pre-formed inlet/outlet openings, or the openings may be formed by pressure applied to the outside or inside of the cartridge. For example, water pressure may be applied to the exterior of the cartridge **1** to form an inlet opening, and beverage pressure inside the cartridge may form an outlet opening in the cartridge, e.g., a septum, burstable seal or other structure may open in response to pressure.

In this embodiment, when the larger first cartridge **1***a* is received into the cartridge holder **3** and the cover **8** is moved to the closed position, the inlet and outlet ports **50**, **52***a* may form openings in a top of the cartridge **1***a* so that water or other fluid may be provided into the cartridge **1***a* via the inlet port **50**, and beverage may be received from the cartridge **1***a* via the outlet port **52***a*. However, a second outlet port **52***b* does not contact the first cartridge **1***a* because the first cartridge **1***a* is not tall enough to contact the outlet second port **52***b*. In contrast, when the second cartridge **1***b* is received in the cartridge holder **3**, the inlet port **50** may form an opening in a top of the cartridge **1***b* when the cover **8** is in the closed position, but the first outlet port **52***a* does not penetrate the second cartridge **1***b* because the second cartridge **1***b* is smaller in diameter at the rim **19**. Instead, the second outlet port **52***b* may form an outlet opening in a bottom of the cartridge **1***b* because in this embodiment, the second cartridge **1***b* is taller than the first cartridge **1***a* so that the piercing element of the outlet port **52***b* penetrates the second cartridge **1***b*. Thus, beverage formed in the cartridge **1***b* may flow to the second outlet port **52***b*. Of course, it will be understood that other inlet/outlet port arrangements are possible for use with different cartridges and are not limited to this illustrative embodiment. For example, the inlet and/or outlet ports may introduce or receive fluid in any suitable locations relative to the cartridges, such as at the top, bottom, side or other locations of the cartridge, and may depend on the cartridge arrangements.

Cartridges used with various cartridge holder embodiments may be arranged in different ways, and may depend at least in part on the nature of how a beverage medium in the cartridge is accessed to form a beverage. FIG. **6** shows an exploded view and FIG. **7** shows an assembled view of one cartridge embodiment that may be used in some embodiments. Details regarding such a cartridge are provided in U.S. Pat. No. 8,361,527, which is hereby incorporated by reference. As will be understood, the cartridge **1** may contain any suitable beverage medium **20**, e.g., ground coffee, tea leaves, dry herbal tea, powdered beverage concentrate, dried fruit extract or powder, powdered or liquid concentrated bouillon or other soup, powdered or liquid medicinal materials (such as powdered vitamins, drugs or other pharmaceuticals, nutriceuticals, etc.), and/or other beverage-making material (such as powdered milk or other creamers, sweeteners, thickeners, flavorings, and so on).

In this illustrative embodiment, the cartridge **1** includes a container **12** that includes an interior space **14** having a first chamber **14***a* and a second chamber **14***b* that are separated by a filter **30**. The container **12** may have a frustoconical cup shape with a sidewall **17** and an opening **13**, although other arrangements are possible, e.g., the container **12** may have a fluted, conical, or cylindrical shape, may be in the form of a square or rectangular cup, a domed cup, a sphere or partial sphere, or other suitable form, may have a fluted, corrugated, or otherwise shaped sidewall, and so on. Also, the container **12** need not necessarily have a defined shape, as is the case with some beverage sachets and pods. For example, although the container **12** in this embodiment has a relatively rigid and/or resilient construction so that the container **12** tends to maintain its shape, the container **12** could be made to have a more compliant and/or deformable arrangement, e.g., like a sachet container made from a sheet of deformable material. Thus, an interior space defined by the container **12** may be formed only after the container material is formed around a beverage medium, filter and/or other

cartridge components, similar to when two filter paper layers (container material) are joined together around a charge of coffee grounds to form a pod or other form of cartridge.

The opening **13** may be closed by a lid **38**, e.g., a flexible sheet of foil and polymer laminate material that is attached to a rim **19** of the container **12**. (Although in this embodiment the rim **19** is arranged as an annular flange-like element, the rim **19** may be arranged in other ways. For example, the rim **19** may be the top edge of the sidewall **17** without any flange element.) The filter **30** may be attached to the lid **38** at a periphery **32** that is spaced inwardly and away from the rim **19**, e.g., for reasons discussed more below. In addition, the filter **30** may extend from the periphery **32** at least partially into the interior space **14**. In this illustrative embodiment, the filter **30** may have a substantially frustoconical shape with fluted or pleated sidewalls and a generally flat bottom **31**, as shown. However, the filter **30** may have any suitable shape, such as a cylindrical shape, a square cup shape, a domed shape, a flat sheet, or other. Also, the use of a filter **30** is not necessary, and instead the cartridge **1** may be filterless.

When using the cartridge **1** to form a beverage, the lid **38** and/or the container **12** may be pierced to introduce liquid into the cartridge and receive beverage from the cartridge. (As used herein, "beverage" refers to a liquid substance intended for drinking that is formed when a liquid interacts with a beverage medium. Thus, beverage refers to a liquid that is ready for consumption, e.g., is dispensed into a cup and ready for drinking, as well as a liquid that will undergo other processes or treatments, such as filtering or the addition of flavorings, creamer, sweeteners, another beverage, etc., before being consumed.) To introduce liquid into the cartridge, for example, as shown in FIG. **8**, a portion of the lid **38** generally circumscribed by the periphery **32** may be pierced by an inlet piercing element **50** (e.g., a needle) so that water or other liquid may be injected into the cartridge **1**. Other inlet piercing arrangements are possible, such as multiple needles, a shower head, a non-hollow needle, a cone, a pyramid, a knife, a blade, etc. A beverage machine that uses the cartridge may include multiple piercing elements of the same type or of different types, as the invention is not limited in this respect. In another arrangement, a beverage machine may include a piercing element (such as a spike) that forms an opening and thereafter a second inlet element (such as a tube) may pass through the formed hole to introduce liquid into (or conduct liquid out of) the container. In other embodiments, the lid **38** may be pierced, or otherwise effectively opened for flow, by introducing pressure at an exterior of the lid **38**. For example, a water inlet may be pressed and sealed to the lid **38** exterior and water pressure introduced at the site. The water pressure may cause the lid **38** to be pierced or otherwise opened to allow flow into the cartridge **1**. In another arrangement, the lid **38** may include a valve, conduit or other structure that opens when exposed to a suitable pressure and/or when mated with a water inlet tube or other structure. Fluid introduced into the cartridge **1** may be slowed, distributed or otherwise acted on by a flow distributor **33**, e.g., an element with holes to help more evenly wet the beverage medium **20**.

The cartridge **1** may also be penetrated by an outlet piercing element **52***b* (e.g., a needle) at a bottom **16** of the container **12**, or by an outlet piercing element **52***a* at a second portion of the lid **38** outside of the periphery **32** and apart from the inlet opening. As with the inlet piercing arrangement, the outlet piercing arrangement may be varied in any suitable way. Thus, the outlet piercing element **52** may include one or more hollow or solid needles, knives, blades, tubes, and so on. Alternately, the cartridge **1** may include a valve, septum or other element that opens to permit beverage to exit when liquid is introduced into the cartridge, but otherwise remains closed (e.g., to protect the beverage medium from external conditions such as oxygen, moisture or others). In such a case, no piercing element for forming the outlet opening is necessarily required although may be used, e.g., to allow the valve or other element to open. Also, in this illustrative embodiment the piercing element **52** remains in place to receive beverage as it exits the opening formed in the container **12** or lid **38**. However, in other embodiments, the piercing element **52** may withdraw after forming an opening, allowing beverage to exit the opening and be received without the piercing element **52** being extended into the cartridge **1**.

It should be understood that while a cartridge arranged like that in FIGS. **6-8** may be used in an embodiment like that in FIGS. **3** and **5**, other cartridge types are possible, such as those described in U.S. Pat. Nos. 6,607,762; 6,645,537; 6,589,577 and others. Also, it should be appreciated that cartridges that can be received by a cartridge holder **3** may differ in shape, in addition to, or instead of, size (at least in a region where the cartridges are engaged by the cartridge holder to support the cartridge). For example, U.S. Pat. No. 8,361,527 also describes a cartridge with an irregular rim shape, which is shown in FIG. **9**. In this embodiment, the cartridge **1** is arranged similarly to that in FIGS. **6-8**, but the container **12** has a rim **19** with a circular portion **19***a* and a spout portion **19***b* that extends from the circular portion **19***a*. Thus, the rim **19** has an irregular shape, and the cartridge holder **3** may be arranged to not only accommodate a larger overall rim size of the cartridge **1**, but also the irregular shape of the rim **19**.

The example of FIG. **5** is only one that illustrates how different inlet and/or outlet ports **50**, **52** may be used for different cartridges. For example, in some embodiments, one or more ports **52** may be movable to exchange fluid, or not, with a cartridge in the holder **3**. For example, FIG. **10** shows a schematic side view of the cartridge holder **3** of FIG. **3** with a second cartridge **1***b* having a relatively smaller, circularly-shaped rim diameter (e.g., as seen in FIGS. **6** and **7**) received in the holder **3**. In contrast, FIG. **11** shows a schematic side view of the cartridge holder **3** of FIG. **3** with a first cartridge **1***a* having a relatively larger rim diameter and an irregular rim shape (e.g., as seen in FIG. **9**) received in the holder **3**. The view in FIG. **10** is similar to that shown in FIG. **5** for the second cartridge **1***b*. That is, the second cartridge **1***b*, which has a relatively small circular rim **19** in this embodiment, is pierced at the top by the inlet port **50** to accommodate downward inflow of fluid into the cartridge **1***b*, and pierced at the bottom by the second outlet port **52***b* to accommodate downward outflow of beverage from the cartridge **1***b*.

However, with the first cartridge **1***a* held in the cartridge holder **3**, the top of the cartridge is pierced by both the inlet port **50** and the first outlet port **52***a*. The first cartridge **1***a* may be pierced by the first outlet port **52***a* at an area of the lid **38** which is located in the spout area near the spout portion **19***b* of the rim **19**, although other areas of the lid are possible. Inclining the cartridge holder **3** and cartridge **1***a* such that the spout portion **19***b* is at a lower end of the cartridge **1***a* may aid in removing beverage from the cartridge **1***a*, since beverage may collect in the spout area for outflow in an upward direction.

Note that while in the FIG. **5** embodiment, the first cartridge **1***a* is too short to contact the second outlet port **52***b*, this need not be the case and the first cartridge **1***a* may be

made taller. In such a case, the second outlet port **52***b* may be moved out of a cartridge receiving space so that the port **52***b* can avoid contact with the cartridge **1***a*. Such movement may be accomplished in different ways, such as by a motorized drive, a linkage, having a user physically move one of the ports into/out of a cartridge receiving area, and others. In one aspect of the invention, one or more ports may be selected for use with a cartridge based on one or more features of the cartridge that is inserted into the cartridge holder **3**. For example, insertion of a cartridge having a relatively larger rim diameter may cause the second outlet port **52***b* to be moved out of a cartridge receiving area so as to avoid potential contact with the cartridge **1**. In other embodiments, insertion of a particular cartridge type may release a port for movement, e.g., insertion of the larger rim cartridge may release the second outlet port **52***b* so that the cartridge **1***a* may contact the second outlet port **52***b* and move it.

For example, FIGS. **12** and **13** show an illustrative embodiment in which insertion of a cartridge having a spout, such as that shown in FIG. **9**, causes the second outlet port **52***b* to move out of a cartridge receiving area. In this embodiment, one of the movable portions **32**, e.g., a trigger **33**, may contact the spout area of the cartridge **1***a* and be moved radially outwardly, i.e., to the right in FIGS. **12** and **13**. The trigger **33** may be coupled to the second outlet port **52***b* by a linkage that causes the second outlet port **52***b* to pivot about an axis **53** as the sliding portion **32** is moved radially outwardly. This may move the second outlet port **52***b* out of an area of potential contact with the cartridge **1***a*. The trigger **33** may be spring loaded such that when the first cartridge **1***a* having a spout is removed from the cartridge holder **3**, the trigger **33** may move radially inwardly, allowing the second outlet port **52***b* to pivot back into a cartridge receiving area. Thus, if a second cartridge **1***b* is inserted into the holder **3** having no spout, the trigger **33** may remain stationary, and the second outlet port **52***b* may pierce the second cartridge **1***b* at its bottom or other suitable location. The second outlet port **52***b* may include or be connected to a conduit to conduct beverage from the second cartridge **1***b* to a dispensing area of the beverage forming machine **10**, or beverage may simply exit the cartridge **1***b* without being conducted by a conduit.

In another embodiment, movement of the trigger or other part of the cartridge holder **3** may release one or more ports for movement, e.g., based on contact with a cartridge, so that the port does not pierce or otherwise interact with the cartridge to exchange fluid. For example, FIG. **14** shows an embodiment in which a trigger **33** like that in FIGS. **12** and **13** may be moved by a contact with a spout of a first cartridge **1***a*. Movement of the trigger **33** may release the second outlet port **52***b* for movement upon contact with the cartridge **1***a* so that the second outlet port **52***b* does not substantially resist movement. For example, with the first cartridge **1***a* inserted into the cartridge holder **3**, a bottom of the first cartridge **1***a* may contact the second outlet port **52***b* and pivot the port **52***b* about a horizontal axis **54** so the port **52***b* moves out of a cartridge receiving area and does not pierce the cartridge **1***a*. However, if a second cartridge **1***b* is inserted into the cartridge holder **3**, the lack of movement of the trigger **33** may lock the second outlet port **52***b* in place so that it pierces or otherwise interacts with the second cartridge **1***b* to receive beverage. In this embodiment, the trigger **33** is linked to a latch **331** that engages with the second outlet port **52***b* to prevent pivoting of the port **52***b* about the axis **54** when the trigger **33** is positioned to the left. However, movement of the trigger **33** to the right disengages the latch **331** from the port **52***b*, allowing the port **52***b* to pivot about the axis **54**. The trigger **33** may be spring loaded to move to the left as shown in FIG. **14**; thus, the latch **331** may normally engage the port **52***b* unless the trigger **33** is moved, e.g., by a first cartridge **1***a*.

Although the examples above show and describe embodiments in which only one outlet port is moved, other arrangements are possible, such as where two or more outlet ports are moved, one or more inlet ports are moved, or other combinations of port selections are made. Also, movement of inlet and/or outlet ports may be effected by a motor drive or other mechanism, and may be controlled by based on reading of a machine readable feature or other indicia on a cartridge. For example, the machine **10** may read an RFID tag, barcode, etc., on a cartridge **1**, and make suitable port selections based on a cartridge type or other information associated with the identified cartridge **1**.

FIGS. **15** and **16** show an exploded view and an assembled view of a cartridge holder, associated cover, handle actuator and other selected components of a beverage forming apparatus **10**. In this embodiment, the engagement portion of the cartridge holder **3** includes a plurality of movable portions **32** in the form of "fingers" or wall portions that are joined together at a bottom of the engagement portion, as in FIG. **4**. This embodiment also includes a trigger **33** to cause and/or allow movement of an outlet port from a cartridge receiving area. That is, this embodiment is arranged to receive both a first cartridge **1***a* that has an irregular rim having a circular portion and spout portion, and a second cartridge **1***b* that has a circular rim with a diameter smaller than that of the circular portion of the first cartridge **1***a*. Contact of the spout area of the first cartridge **1***a* with the trigger **33** causes the trigger **33** to move radially outwardly, releasing the second outlet port **52***b* for movement (or actually moving the second outlet port **52***b*). Note that the wall portions **32** of the engagement portion are arranged to provide a suitable opening for the second outlet port **52***b* to move into/out of the cartridge receiving area as needed.

As can be seen in FIG. **15**, the engagement portion is received into a hole **35** in a portion of the frame **6** that helps define the cartridge holder **3**. In this embodiment, the engagement portion is supported in the hole **35** so that the wall portions **32** located opposite the trigger **33** have a smaller range of radial motion than wall portions **32** located nearer the trigger **33**. That is, one or more wall portions **32** opposite the trigger **33** may be permitted to move radially outwardly to some extent, but then contact the hole **35** or other part of the frame **6** so the wall portion(s) **32** are prevented from further outward radial movement. This may help the cartridge holder **3** to urge a cartridge **1***a* having a spout section into proper contact with the trigger **33** and move the trigger **33** suitably radially outwardly. In addition, this may help the cartridge holder **3** to properly position the cartridge **1***a* for alignment with an inlet and outlet port **50**, **52***a*. That is, the trigger **33** may be biased to move radially inwardly by a spring or other resilient element of suitable strength so that insertion of the cartridge having a spout section causes the wall portion(s) **32** opposite the trigger **33** to flex outwardly and contact the hole **35** or other stop of radial movement before the cartridge **1***a* is fully inserted into the opening **31**. Further insertion of the cartridge **1***a* may then cause the trigger **33** to slide outwardly because the wall portion(s) **32** opposite the trigger **33** are prevented from further outward radial movement. This may ensure that the cartridge **1** is properly positioned for piercing by an inlet and/or outlet piercing element.

FIG. **16** also shows how in this embodiment the cover **8** may be moved relative to the cartridge holder **3**. The cover **8** is arranged for pivotal movement relative to the frame **6** about a cover pivot **61** based on movement of a handle **5** which is pivotally mounted to the cover **8** at a handle pivot **63**. A plate **81** is also pivotally mounted to the frame **6** about a plate pivot **62** and moves based on movement of the handle **5**. The plate **81** operates to contact a cartridge **1** placed in the cartridge holder **3**, and push the cartridge **1** into the holder **3** so that the cartridge **1** is fully received into the holder **3** before the cover **8** engages the cartridge **1**. This helps ensure that the cartridge **1** is fully seated in the holder **3** before piercing elements on the cover **8** pierce the cartridge **1**. A pivot pin **64** of the handle **5** is engaged with a slot **82** of the plate **81** and moves in a cam slot **65** of the frame **6** so that as the handle **5** is pivoted about the handle pivot **63** from an open position (shown in FIG. **16**) to a closed position, the pivot pin **64** moves in the cam slot **65**, thereby pivoting the plate **81** about the plate pivot **62** toward the cartridge holder **3**. At the same time, the cover **8** is pivoted about the cover pivot **63** to move toward the cartridge holder **3**. The plate **81** is arranged to contact a cartridge **1** in the holder **3** before the cover **8**, forcing the cartridge **1** to be seated into the holder **3**. This action may cause movable portions **32** of the engagement portion to move as needed to receive the cartridge **1**. Further movement of the handle **5** toward the closed position causes the pivot pin **64** to move further downwardly in the cam slot **65** so the cover **8** engages the cartridge **1**. In this embodiment, piercing elements at the inlet and/or outlet ports **50**, **52***a* may pierce the cartridge **1**, although such piercing elements are not required. With the handle **5** at a closed position, the pivot pin **64** may move into a "J" shaped section of the cam slot **65** which effectively locks the cover **8** and the plate **81** in place over the cartridge holder **3**. Lifting of the handle **5** from the closed position reverses movement of the pivot pin **64** in the cam slot **65**, thereby pivoting the cover **8** and plate **81** to the open positions.

FIG. **17** shows a schematic block diagram of various components that may be included in a beverage forming apparatus **100** in one illustrative embodiment. Those of skill in the art will appreciate that a beverage forming apparatus **100** may be configured in a variety of different ways, and thus aspects of the invention should not be narrowly interpreted as relating only to one type of beverage forming apparatus. In this embodiment, water or other precursor liquid may be provided by a liquid supply **15** to mix with a beverage material at a beverage forming station **11**. The beverage material (such as coffee grounds, tea leaves, a powdered drink mix, etc.) may be provided in a cartridge **1**, or not, and beverage produced by mixing the liquid with the beverage material may be dispensed into the container **2** via a beverage outlet.

The liquid supply **15** in this embodiment controls the volume of liquid provided to the beverage forming station **11** by filling the tank to a liquid dispense level **159**, **160** and then pressurizing the tank **152** by way of an air pump **154** so that liquid in the tank **152** is forced out of the conduit **156** to the beverage forming station **11**. The volume of liquid delivered to the beverage forming station **11** is equal to the volume in the tank **152** between the liquid delivery level **159**, **160** and a post-delivery level **158** at a bottom of the conduit **156** in the tank **152**. Since there are two delivery levels **159**, **160** in this embodiment, two different volumes can be provided to the beverage forming station **11**. However, more than two levels, or a single level, may be used.

In this embodiment, the liquid supply **15** provides liquid to the tank **152** via a valve **151** that is coupled to a source W. The source W may have any suitable arrangement, e.g., may provide liquid from a storage tank, a mains water supply or other source. Thus, in some cases, the liquid provided to the tank **152** may vary in temperature by a wide degree depending on various factors, such as time of year, a temperature of a room in which the machine **10** is located, etc. For example, if the source W is a reservoir that is filled by a user, the temperature of liquid in the reservoir may vary between room temperature (e.g., if liquid sits in the reservoir for an extended time) and a cooler temperature (e.g., if the reservoir has just been filled with water that is dispensed from a tap).

To provide liquid to the tank **152** in this embodiment, the valve **151** is controlled by the control circuit **16** to open and close to provide a desired volume of liquid to the tank **152**. For example, if the tank **152** is empty or at the post-dispense level **158**, the valve **151** may be opened until a conductive probe or other liquid level sensor **157** provides a signal to the control circuit **16** that indicates when liquid arrives at the dispense level **159**, **160**. In response to the level sensor **157** detecting liquid at the sensor **157**, the control circuit **16** may close the valve **151**. Of course, other arrangements are possible, such using a pump to move liquid from a storage reservoir to the tank **152**.

Although in this embodiment the liquid level sensor includes a pair of conductive probes capable of contacting liquid in the tank **152** and providing a signal (e.g., a resistance change) indicative of liquid being present at respective dispense levels **159** or **160** in the tank **152**, the liquid level sensor may be arranged in other ways. For example, the sensor may include a microswitch with an attached float that rises with liquid level in the tank **152** to activate the switch. In another embodiment, the liquid level sensor may detect a capacitance change associated with one or more liquid levels in the tank, may use an optical emitter/sensor arrangement (such as an LED and photodiode) to detect a change in liquid level, may use a pressure sensor, may use a floating magnet and Hall effect sensor to detect a level change, and others. Thus, the liquid level sensor is not necessarily limited to a conductive probe configuration. Moreover, the liquid level sensor may include two or more different types sensors to detect different levels in the tank. For example, a pressure sensor may be used to detect liquid at the dispense level **160** (e.g., complete filling of the tank **152** may coincide with a sharp rise in pressure in the tank **152**), while a conductive probe may be used to detect liquid at the other dispense level **159**.

Further, a liquid level sensor need not be used to fill the tank to the dispense level **159**, **160**. Instead, other techniques may be used to suitably fill the tank **152**, such as opening the valve **151** for a defined period of time that is found to correspond to approximate filling of the tank **152** to the desired level. Of course, other arrangements for providing liquid to the tank **152** are possible, such as by a pump (e.g., a centrifugal pump, piston pump, solenoid pump, diaphragm pump, etc.), gravity feed, or other, and the way by which the tank is filled to the dispense level **159**, **160** may depend on the technique used to provide liquid to the tank. For example, control of a volume of liquid provided to fill the tank **152** to the dispense level **159**, **160** may be performed by running a pump for a predetermined time, detecting a flow rate or volume of liquid entering the tank **152** (e.g., using a flow meter), operating a pump for a desired number of cycles (such as where the pump is arranged to deliver a

known volume of liquid for each cycle), detecting a pressure rise in the tank **152** using a pressure sensor, or using any other viable technique.

Liquid in the tank **152** may be heated by way of a heating element **153** whose operation is controlled by the control circuit **16** using input from a temperature sensor or other suitable input. Of course, heating of the liquid is not necessary, and instead (or additionally) the apparatus **100** may include a chiller to cool the liquid, a carbonator to carbonate the liquid, or otherwise condition the liquid in a way that alters the volume of liquid in the tank **152**. (Generally speaking, components of the liquid supply **15** that heat, cool, carbonate or otherwise condition liquid supplied to the beverage forming station **11** are referred to as a "liquid conditioner.")

In this embodiment, liquid may be discharged from the tank **152** by an air pump **154** operating to force air into the tank **152** to pressurize the tank and force liquid to flow in the conduit **156** to the beverage forming station **11**. Since the conduit extends downwardly into the tank **152**, the volume of liquid delivered to the forming station **11** is defined as the volume in the tank **152** between the dispense level **159**, **160** and the bottom end of the conduit **156**. Again, liquid may be caused to flow from the tank **152** to the beverage forming station **11** in other ways. For example, a pump may be used to pump liquid from the tank **152** to the forming station **11**, liquid may be allowed to flow by gravity from the tank **152**, and others. A vent **155**, which can be opened or closed to vent the tank **152**, may be provided to allow the tank **152** to be filled without causing a substantial rise in pressure in the tank **152** and to allow liquid to be delivered from the tank **152** by pressurizing the tank using the air pump **154**. In this embodiment, the vent **155** is actually not controlled by the control circuit **16**, but remains always open with an orifice of suitable size to allow venting for filling of the tank **152**, and air pressure buildup in the tank **152** to allow liquid delivery. Other flow control features may be provided as well, such as a check valve or other flow controller that can prevent backflow in the conduit between the source W and the tank **152**, or between the tank **152** and the beverage forming station **11**.

The beverage forming station **11** may use any beverage making ingredient, such as ground coffee, tea, a flavored drink mix, or other beverage medium, e.g., contained in a cartridge **1** or not. Alternately, the beverage forming station **11** may function simply as an outlet for heated, cooled or otherwise conditioned water or other liquid, e.g., where a beverage medium is contained in the container **2**. Once liquid delivery from the tank **156** to the station **11** is complete, the air pump **154** (or other air pump) may be operated to force air into the conduit **156** to purge liquid from the beverage forming station **11**, at least to some extent.

Operation of the valve **151**, air pump **154** and other components of the apparatus **100** may be controlled by the control circuit **16**, e.g., which may include a programmed processor and/or other data processing device along with suitable software or other operating instructions, one or more memories (including non-transient storage media that may store software and/or other operating instructions), temperature and liquid level sensors, pressure sensors, input/output interfaces, communication buses or other links, a display, switches, relays, triacs, or other components necessary to perform desired input/output or other functions.

In accordance with an aspect of the invention, the beverage forming apparatus may include multiple detectors to detect characteristics of a cartridge received in the cartridge holder. Operation of the apparatus **100** may be controlled by the control circuit **16** based on information detected by the detectors. For example, in the embodiment shown in FIG. **17**, the apparatus includes first, second and third detectors **161**, **162**, **163** that each detect a different characteristic regarding a cartridge **1** in the cartridge holder **3**. A first detector **161** may detect the presence or absence of a cartridge **1**, e.g., may include an infrared detector that illuminates an area of the cartridge holder **3** with infrared light and detects whether infrared light is reflected by a cartridge or not. Detection of a suitable amount or other level of reflected light may be used to determine that a cartridge **1** is present, whereas no or lower light levels may indicate the absence of a cartridge. Such an infrared detector may include an infrared emitter and a photodetector or other suitable element(s). Other detector arrangements are possible, such as mechanical switches, a bar code reader, an RFID interrogator, etc.

A second detector **162** may detect a type of cartridge, e.g., may detect whether a cartridge includes a spout portion or not. The second detector may be arranged in a variety of different ways, and in one embodiment may include the trigger **33** of FIGS. **12-16** and a switch to detect movement of the trigger **33**. For example, the trigger **33** may include a magnet that moves with the trigger **33** and a reed or other suitable switch may detect the presence or absence of the magnet, thereby detecting movement of the trigger **33**. Other arrangements for the second detector **162** are possible, such as an optical detector, bar code reader, etc.

The third detector **163** may detect information related to whether a cartridge is authorized for use with the beverage forming apparatus, and may include a bar code reader, a camera or other image capture device with image analysis capability, an RFID interrogator, and others. In this illustrative embodiment, the third detector **163** includes an illumination element that illuminates a portion of a cartridge with suitable light, e.g., one or more LED sources may illuminate a cartridge with light having any suitable set of wavelengths. The third detector **163** may also include a light detector that is arranged to detect light emitted and/or reflected by a cartridge portion and assess whether the light detected is consistent with an authorized cartridge. For example, authorized cartridges may carry a security ink or other material that provides a specific spectral response to being illuminated by certain light. The third detector **163** may detect whether the spectral response is present, and if so, indicate that the cartridge is authorized for use in forming a beverage.

The control circuit **16** may control operation of the liquid supply **15** and/or other portions of the apparatus **100** based on information detected by the first, second and/or third detectors **161**, **162**, **163**. For example, if no cartridge is detected by the first detector **161** and an operator presses a brew indication button, the control circuit **16** may cause the apparatus **100** to perform a cleaning operation by which the cartridge holder **3** and/or other parts of the apparatus **100** are cleaned. However, if a cartridge **1** is detected, the control circuit **16** may cause the display of beverage forming options to a user at the user interface **14**, may start a beverage creation cycle, may begin heating of water in the tank **152**, etc. As another example, if the second detector **162** detects a particular type of cartridge, the control circuit **162** may control the system to adjust beverage forming parameters in some way, e.g., by adjusting a heating temperature, an amount of liquid used to make a beverage, displaying and requiring particular user input to form a beverage, and so on. The control circuit **16** may prevent all or certain ones of beverage production processes if a cartridge is not detected by the third detector **163** to be an authorized one. Instead, the

control circuit **16** may only permit a cleaning operation, provided no cartridge is detected in the cartridge holder. Alternately, the control circuit **16** may cause the apparatus to perform a default beverage process, e.g., including a specific set of brew water temperature, volume, delivery time, etc.

While aspects of the invention may be used with any suitable cartridge, or no cartridge at all, some cartridges may include features that enhance the operation of a beverage forming apparatus **100**. As is known in the art, the cartridge **1** may take any suitable form such as those commonly known as a sachet, pod, capsule, container or other. For example, the cartridge **1** may include an impermeable outer covering within which is housed a beverage medium, such as roasted and ground coffee or other. The cartridge **1** may also include a filter so that a beverage formed by interaction of the liquid with the beverage medium passes through the filter before being dispensed into a container **2**. As will be understood by those of skill in the art, cartridges in the form of a pod (e.g., having opposed layers of permeable filter paper encapsulating a beverage medium) may use the outer portion of the cartridge **1** to filter the beverage formed. The cartridge **1** in this example may be used in a beverage machine to form any suitable beverage such as tea, coffee, other infusion-type beverages, beverages formed from a liquid or powdered concentrate, etc. Thus, the cartridge **1** may contain any suitable beverage medium, e.g., ground coffee, tea leaves, dry herbal tea, powdered beverage concentrate, dried fruit extract or powder, powdered or liquid concentrated bouillon or other soup, powdered or liquid medicinal materials (such as powdered vitamins, drugs or other pharmaceuticals, nutriaceuticals, etc.), and/or other beverage-making material (such as powdered milk or other creamers, sweeteners, thickeners, flavorings, and so on). In one illustrative embodiment, the cartridge **1** contains a beverage medium that is configured for use with a machine that forms coffee and/or tea beverages, however, aspects of the invention are not limited in this respect.

As used herein, "beverage" refers to a liquid substance intended for drinking that is formed when a liquid interacts with a beverage medium. Thus, beverage refers to a liquid that is ready for consumption, e.g., is dispensed into a cup and ready for drinking, as well as a liquid that will undergo other processes or treatments, such as filtering or the addition of flavorings, creamer, sweeteners, another beverage, etc., before being consumed.

Having thus described several aspects of at least one embodiment of this invention, it is to be appreciated various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be part of this disclosure, and are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description and drawings are by way of example only.

What is claimed is:

1. A beverage forming apparatus, comprising:

a frame arranged to support components of the beverage forming apparatus;

a cartridge holder including a cartridge engagement portion that defines an opening and that is arranged to engage with a cartridge placed in the opening and support a weight of the cartridge, the cartridge having a rim, and the engagement portion including one or more compliant sections that are arranged to contact regions of first and second cartridges at the rim of the cartridge, the regions at the rim of the first and second cartridges being differently sized and/or shaped relative to each other, and the one or more compliant sections being movable relative to the cartridge holder to adjust a size and/or shape of the opening to accommodate and engage with the differently sized and/or shaped regions at the rims of the first and second cartridges;

a cover arranged to cooperate with the cartridge holder to at least partially enclose a cartridge held by the cartridge holder for formation of a beverage using the cartridge; and

a liquid supply system at least partially supported by the frame arranged to provide a liquid for combination with a beverage medium in a cartridge held by the cartridge holder to form a beverage.

2. The apparatus of claim **1**, wherein the one or more compliant sections each include a resilient element that deforms in response to insertion of the first or second cartridge into the opening of the cartridge holder.

3. The apparatus of claim **1**, wherein the one or more compliant sections includes a plurality of wall sections that are movable relative to each other to accommodate the first or second cartridge.

4. The apparatus of claim **1**, wherein the one or more compliant sections includes at least one trigger that is mounted for sliding movement away from the opening.

5. The apparatus of claim **4**, wherein the trigger is movable to receive a spout of the first or second cartridge.

6. The apparatus of claim **1**, wherein the cartridge engagement portion engages with a rim of the first and second cartridge to support a weight of the cartridge, and wherein the first cartridge has a rim with a first diameter, and the second cartridge has a rim with a second diameter that is smaller than the first diameter.

7. The apparatus of claim **1**, wherein the rim of the second cartridge is circular, and the rim of the first cartridge has a circular portion and a spout portion that extends outwardly from the circular portion.

8. The apparatus of claim **1**, wherein the one or more compliant sections includes a plurality of wall portions that extend upwardly from a bottom of the engagement portion, where the wall portions are joined together, to a top of the engagement portion, the wall portions located at the top of the engagement portion being radially movable relative to each other and arranged for engagement with the first and second cartridge.

9. The apparatus of claim **8**, wherein the wall portions are radially movable based on flexing movement of the wall portions relative to the bottom of the engagement portion.

10. The apparatus of claim **1**, wherein the cover includes a liquid inlet to introduce liquid from the liquid supply system to a cartridge held in the cartridge holder.

11. The apparatus of claim **10**, wherein the cover includes a first beverage outlet to receive beverage exiting a cartridge held in the cartridge holder.

12. The apparatus of claim **11**, further comprising a second beverage outlet mounted to the cartridge holder and arranged to receive beverage exiting a cartridge held in the cartridge holder.

13. The apparatus of claim **12**, wherein the second beverage outlet is selectively movable into and out of a cartridge receiving area of the cartridge holder based on whether the first or second cartridge is received in the cartridge holder.

14. The apparatus of claim **13**, wherein the liquid inlet and the first and second beverage outlets each include a piercing element to pierce a cartridge.

15. The apparatus of claim **14**, wherein the piercing elements of the liquid inlet and the first beverage outlet face downwardly and the second beverage outlet faces upwardly

with the cover cooperating with the cartridge holder to at least partially enclose a cartridge.

16. The apparatus of claim **1**, wherein regions of the first and second cartridges where the engagement portion engages with the first and second cartridges have different shapes.

17. The apparatus of claim **1**, wherein regions of the first and second cartridges where the engagement portion engages with the first and second cartridges have different sizes.

* * * * *